A COMPARATIVE ANALYSIS OF TRI-SERVICE ACCREDITATION POLICIES AND PRACTICES

VOLUME I

OF THE ACCREDITATION REQUIREMENTS STUDY REPORT

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EXECUTIVE SUMMARY

The goals of the Susceptibility Model Assessment and Range Test (SMART) Project are to develop an efficient process for the verification and validation (V&V) and configuration management (C/M) of aircraft susceptibility models and to facilitate their quick and cost effective accreditation by applying this new approach to five models frequently used in survivability analyses supporting acquisition decisions. The credibility assessment process thus defined generates various reports that provide a model user with enough information on existing verification, validation (V&V), and configuration management (C/M) data to permit accreditation with a minimum of additional effort. To make these reports most beneficial to accreditation proponents, the SMART Project undertook a study of accreditation requirements.

The study involved a review of existing instructions and directives, as well as interviews with personnel engaged in all aspects of model development and use. The analysis focused on two aspects of typical accreditation decisions: accreditation processes and information requirements. The discussions about comparative accreditation processes and requirements generated significant interest from a wide group of DoD and service officials, and so this accreditation process analysis is reported separately from the findings on accreditation information requirements.

The accreditation processes defined in current and emerging service directives generally require totally independent VV&A with outside experts or officials to conduct it or approve the results. Their purpose is to ensure uniformity and prevent bias in any accreditation decisions. These policies were found to be excessively (and on occasion needlessly) bureaucratic; they involve numerous formal reports and reviews, generally have centralized the accreditation authority, and require extensive coordination to obtain meaningful contributions from the specified review participants. Despite the high degree of process formality, the effectiveness of these processes in yielding quality study results is implicitly dependent on the capabilities and interest of the various review bodies or officials.

In contrast to the stated policies, current accreditation practices are relatively streamlined in that the Verification, Validation and Accreditation (VV&A) efforts are merged into each study process. The underlying VV&A approach involves defining the study measures of effectiveness (MOEs) or measures of performance (MOPs), deriving model acceptance criteria, gathering V&V information to compare with the criteria, and accrediting the model based on that comparison. The procedures used to implement this approach vary widely, and do not appear to be a major concern of typical accreditation agents. Existing practices are much less formal than stated policies would seem to require. The emphasis of current accreditation practices is on collecting and evaluating sufficient information to determine model suitability for the intended application, regardless of the process by which such information is gathered and reviewed.

Our analysis shows that the current VV&A approach appears to be efficient and logical and tends to mitigate potential biases by requiring that application specific accreditation criteria be defined before model selection. The effectiveness of this approach depends explicitly on the competence and integrity of the study analysts.

The major disadvantages noted are: 1) potential inconsistencies in approach implementation; 2) potential biases of the analysts coupled with resource limitations that might cause incomplete data gathering and/or improper comparisons; and 3) a possible lack of uniformity and experience in establishing acceptance criteria for each specific application. Any VV&A policies that are being developed should fulfill the intent of the DoD guidance yet capitalize on the advantageous features of the current practices while minimizing the disadvantages.

A notional concept for model accreditation that fulfills the DoD goals of uniformity and objectiveness and incorporates the efficiency of the current practices while minimizing the variability was developed. This concept decentralizes accreditation responsibility, places V&V responsibility on the study analyst, and provides for independent expert analysts to review the study's MOEs and resultant model acceptance criteria where necessary. With expert concurrence on these two items, the study analysts perform the necessary V&V to ensure that the model satisfies the explicitly stated M/S acceptance criteria tailored to the application at hand. Since the primary burden of thought is placed up front, the accreditation process avoids the costs associated with pro forma execution of V&V procedures not tailored to individual applications.

The V&V reports, configuration management procedures, and accreditation support database produced by the SMART Project facilitate accreditation and are easily integrated into this notional process. Incremental application of the SMART process allows development of the baseline V&V products during the course of several specific applications without excessive expenditures on the part of any one user.

In summary, the notional process suggested in this report coupled with the incremental application of the SMART V&V process would lead to the use of appropriate, accredited models with minimal time and cost impacts on the study sponsor. To put this notional concept into practice the following steps should be implemented:

1. DoD and service accreditation policies should focus on development and use of comprehensive MOEs/MOPs and model acceptance criteria. Requirements for obligatory, independent reviews and formal reports should be minimized.

2. DoD and service agents, responsible for M/S policy development, should charter one, or a few, team(s) of expert analysts to facilitate development and review of MOEs/MOPs and acceptance criteria when requested.

3. The Defense Modeling and Simulation Office (DMSO) should develop guidelines, tailored to each class of applications, for defining MOEs/MOPs.

4. DMSO should sponsor a demonstration effort in which the notional accreditation process is used and independently evaluated.

5. DMSO should seek out opportunities to create automated or expert systems that will assist analysts in defining MOEs/MOPs and acceptance criteria for each application.

TABLE OF CONTENTS

LIST OF FIGURES

TABLE OF CONTENTS
(CONT)

LIST OF TABLES

LIST OF APPENDICES

1. BACKGROUND AND PURPOSE

The goal of the Susceptibility Model Assessment and Range Test (SMART) Project is to develop, document, establish, and transition a process for assessing the credibility of models and/or simulations (M/S) used in the aircraft survivability discipline. The impetus for this goal is to support acquisition decisions (e.g., Cost and Operational Effectiveness Analyses [COEAs] and Defense Acquisition Board [DAB] reviews); test planning and analysis during the development test (DT) and operational test (OT) phases of a program; mission planning; and many other applications requiring analysis of the combat effectiveness of military aircraft. The M/S credibility assessment process involves elements of verification, validation (V&V) and configuration management (C/M). Implementation of this process yields the core information required for accreditation of survivability M/S used in analyses. SMART is producing baseline V&V and C/M information on a range of aircraft survivability M/S and building an accreditation support data base that allows M/S users to learn from and build upon the work of previous M/S users. In this way, M/S accreditation requirements in support of acquisition are more easily identified, and accreditation is more easily (and cheaply) performed.

To maximize the utility of SMART V&V and C/M documentation to the accreditation process, it became necessary to understand what information is required to support accreditation. Since a single source of accreditation information requirements did not exist, SMART commissioned a study to identify the requirements of the various activities that use and accredit M/S across the services. It was intended that comparison between these requirements and the current SMART products provide useful insight into what information should be added to make SMART products most useful to potential accreditation proponents.

Although the initial objective of this study was to determine the most necessary and frequently used information to accredit models and to tailor SMART products accordingly, the focus of the study was expanded when it became apparent that emerging accreditation policies differed markedly from current practices. These differences had to be understood to determine if the current information requirements would be likely to change as the new policies were implemented. Therefore, a more detailed analysis of the various accreditation processes was undertaken as an adjunct to the information requirements analysis. The results of this excursion are the subject of the present report. The companion volume, “Information Requirements in Support of Accreditation,” is available as Report number JTCG/AS-93-SM-20, Volume II.

2. STUDY APPROACH

Information for this study was collected through personal interviews and document reviews. Individuals in the M/S community were contacted to determine the key DoD and service organizations and activities that use survivability M/S and perform VV&A in conjunction with their use. A list of these organizations was developed, and points of contact at each organization were identified (see Appendix A). An interview guide was prepared to obtain consistency between interview results and to

ensure that all critical questions and issues were addressed. The interview guide is contained in Appendix B.

The organizations on the interview list were visited and those persons who perform V&V, develop VV&A policies, or approve or accredit M/S for use within their respective organizations were interviewed. Besides questioning the interviewee using the prepared guide, any written material that addressed VV&A guidelines and established policy, or that documented actual VV&A efforts, was obtained. Information on other suggested points of contact was also requested, thereby broadening the interview base as widely as possible. Summary notes documenting the substance of each interview were prepared and provided to each interviewee for review and comment. This practice ensured that interview statements were clearly understood and that no bias was introduced into the interview summaries. Summaries of the interviews are provided as Appendix C. They are organized in the order shown on the interview list.

The service level documents that contain the VV&A policies were then analyzed to understand and compare official accreditation procedures. The procedures were reduced to process flow diagrams for analysis. Local directives and interview summaries were analyzed to develop descriptive process flow diagrams of the procedures actually followed. Some process flow diagrams were compared and consolidated wherever justified by substantial similarities. The resultant procedural flow diagrams were briefed and discussed at meetings attended by personnel from the parent activities of the various interviewees, and were revised based on comments received. Finally, the official and practical process diagrams were compared and analyzed to determine similarities and differences, advantages and disadvantages.

In comparing and contrasting accreditation policies with actual M/S user practices, several observations on the practicality and effectiveness of both policies and practices emerged. These observations suggested a set of goals that should be the foundation of an effective and efficient accreditation process, and that might form the basis of more practical policy directives. Using these goals as a springboard, a notional accreditation process was formulated which integrated the most desirable features of the various official accreditation policies and actual practices into a process that leads from a clear problem definition, through model selection, accreditation, and use, to a set of supportable study conclusions. The suggested process ties in the key information requirements, identified through the interviews, with the goals for an efficient and effective study process, to produce an accredited model that is suitable for use in a given application.

This report provides an in depth explanation of existing or emergent service policies, actual accreditation practices and a suggested accreditation process. It identifies conclusions derived from the study, formulates an improved notional process that incorporates the SMART V&V approach, and presents recommendations for adopting and testing the notional process with the goal of formulating consistent, efficient, and practical accreditation policies across the services.

3. INTERVIEW FINDINGS

Very few of the interviewees had experience with, or had been involved, in a formal, documented accreditation of a model or simulation. Only the Army Materiel Systems Analysis Activity (AMSAA) and the Army Operational Test and Evaluation Command (OPTEC) had conducted formal model accreditations. Those interviewees pointed out the significant amount of time and resources required for a formal accreditation. Several other interviewees were involved in planning for or conducting their first accreditation.

Several common perceptions and concerns were voiced by many of the interviewees. The most significant concerns were: 1) resource constraints; 2) lack of common V&V techniques and approaches; and 3) problems associated with selecting a model for a study. The major points gleaned from these summaries are highlighted in the following paragraphs. Detailed interview summaries are presented in Appendix C.

3.1 Resource Constraints

Several interviewees, most notably those at the Center for Naval Analyses (CNA) and AMSAA, mentioned VV&A cost as an important consideration. In their view, the value added by collecting extensive information to support accreditation must be weighed against the resources required to complete the accreditation and the importance of the decision. Concerns were also expressed about the cost of formal configuration management procedures. They felt it would be beneficial to know the cost of typical V&V efforts, as well as the cost of applying the SMART V&V process to other models. (SMART is addressing this in its FY 94 tasking.)

Other interviewees pointed out that there is seldom enough time to carry out a formal model accreditation for a particular application since the study results are often required in the matter of a few weeks. The organizations faced with this type of problem are the Army Deputy Chief of Staff for Operations (DCSOPS), the Naval Air Systems Command, Warfare Analysis Division (NAVAIR-526), the Navy Operational Test and Evaluation Force (OPTEVFOR), and the Air Force Aeronautical Systems Command (ASC). Occasionally, the lack of time forces analysts to use models that are not really suited to the study but are either the only ones available or the only ones with which the study analysts are familiar.

3.2 V&V Techniques

Several V&V techniques were mentioned as being valuable in supporting accreditation. Although almost all interviewees recognized the desirability of performing extensive verification code checks and in depth comparisons between model results and real world data, funding and time constraints frequently preclude such extensive V&V. Instead, many model users turn to other less costly methods that are also less beneficial. Such methods typically include reviews of past usage and VV&A results, face validation, and some comparisons between models. OPTEC and AMSAA have employed automated V&V tools (CASE tools) with some success, however, the analysts require a good understanding of the tools available

and how they are best applied. According to the CNA personnel, the most appropriate use of CASE tools is to document the software; current model users are generally hindered by poor documentation.

Many organizations, faced with a lack of time and resources to perform in depth V&V, have relied on prior V&V, face validation, and benchmarking as the basis for informal model accreditation. Among those who use these methods are the Army Aviation and Troop Command (ATCOM), the Air Force Operational Test and Evaluation Center (AFOTEC), AMSAA, OPTEC, ASC, and NAVAIR. A common view is that past usage, coupled with reviews by subject matter experts (SMEs) or comparisons between models, are sufficient to justify model selection and use. Detailed comparisons between the model results and test data are made by organizations engaged in test programs such as AFOTEC and OPTEC. These comparisons are made in parallel with the analysis being performed using the model. Several interviewees specifically mentioned the value of understanding M/S assumptions and limitations, and of performing a sensitivity analysis to build confidence in model results.

A prime factor mentioned in a number of interviews is the importance of well-qualified analysts. Air Force Studies and Analysis Agency (AFSAA), ATCOM, CNA, and some divisions in ASC rely heavily on analysts to understand the models they use and to ensure that they will produce reliable results. They feel that an analyst who uses a few models on a regular basis knows model limitations well and is best suited to determine if the model is applicable to a particular study. This corporate memory is perishable, however, and, without good M/S documentation, can result in M/S being used just because they have always been used.

One other concern related to V&V techniques is data validation. Many organizations addressed this issue in the documentation provided as part of the interview. Both OPTEC and ASC personnel stressed that study validity was directly related to using valid data from an approved source for a study.

3.3 Model Selection Concerns

One point brought out by both the OPTEC and the Air Warfare Center (AWC) interviewees seems obvious, but is so important that it bears repeating. Using an accredited model does not guarantee valid study results. Correct MOPs or MOEs for the study must be chosen before the study begins. The use of inappropriate MOPs or MOEs can lead to erroneous results, even if the model is an accurate representation of the system being studied. Appropriate MOEs or MOPs should be derived from the study objectives. This point cannot be overemphasized, considering the relationship between study MOEs and model acceptance criteria, a point that will be amplified in later paragraphs. OPTEC has a guide for choosing their M/S acceptance criteria, and AMSAA has included M/S acceptance criteria as a major item in their accreditation reviews. A sample set of questions for defining M/S acceptance criteria is provided in Appendix D.

Another issue mentioned by a large number of interviewees was configuration management. Knowledge of all changes to a model that make it different from the

one described in the documentation is essential to determining its suitability for a particular application. Many also expressed concerns over the time it takes to get proposed and needed changes incorporated, tested, and distributed to the users.

The expressed concerns about configuration management point out the importance of being able to relate V&V information to a particular version of a model. This concern is the basis for the SMART Project's efforts to develop common configuration management requirements and guidelines that are linked to the V&V process, so that the user has a means of relating the V&V results to all applicable model versions. These FY94 efforts are being undertaken in conjunction with government and industry M/S developers.

4. ANALYSIS OF ACCREDITATION POLICIES

DoD Directive 5000.59, entitled "DoD Modeling and Simulation (M&S) Management" contains the following direction: "The DoD Components shall establish verification, validation, and accreditation (VV&A) policies and procedures for M/S applications managed by the DoD Component. The 'DoD M/S Executive Agent' for a general-use M/S application shall establish VV&A procedures for that application." In response to this direction the Army has promulgated Army Regulation (AR) 5-11 ("Army Model and Simulation Management Program".) The Navy is developing a parallel instruction. Two significantly different Navy drafts were circulated for comment during 1993. The latest draft contains some of the philosophy from the previous drafts but is significantly different in many respects. The Air Force has established an office within the headquarters staff (Code XOM) and is developing Air Force M/S management policies that include VV&A guidelines. At the time of this writing, these policies were also in draft form and were undergoing review.

4.1 Army Accreditation Policy Description;

The Army M/S accreditation process is promulgated in AR 5-11. This regulation states that the defined process is applicable to new model developments. However, analysis shows that it could be used equally well for existing models. The prescribed process involves collection, review of specific types of information by certain assigned proponents in a series of sequential steps, and reporting. These steps include a V&V review, an accreditation review for a class of applications, and an accreditation review for a specific application. The regulation gives examples of the types of information that should be reviewed at each step in the process. The process and information requirements defined in AR 5-11 are amplified and explained in an Army pamphlet, DA PAM 5-11. (This pamphlet was available in its final draft form at the time this study report was prepared.)

A "class of applications" is defined as a generic set of purposes. Examples of different classes of applications are: research and development; test and evaluation; education and training; production and logistics; or analysis (including COEAs) in support of system acquisitions. A specific application is the use of a model in a particular problem. An example would be a COEA on a proposed weapon system.

AR 5-11 specifies the accreditation process and requirements for a class of applications and for specific applications. Accreditation for a specific application presupposes accreditation for the appropriate class of applications. A diagram depicting the accreditation process for a class of applications is shown in Figure 1.

As indicated in the figure, the V&V proponent is responsible for preparing a V&V plan for each model that is to be accredited for a class of applications. This V&V plan includes management information on tasks, schedule, and resources as well as analysis information such as scope, limitations, constraints, methodology, sources of data, and, most importantly, M/S acceptance criteria. When V&V is completed, the results are detailed in a report that includes a description of the real world entity being modeled, the intended purpose of the M/S, the design requirements, a description of the V&V that was performed, the extent to which the M/S met the V&V acceptance criteria, and any recommendations for M/S modifications to improve acceptability.

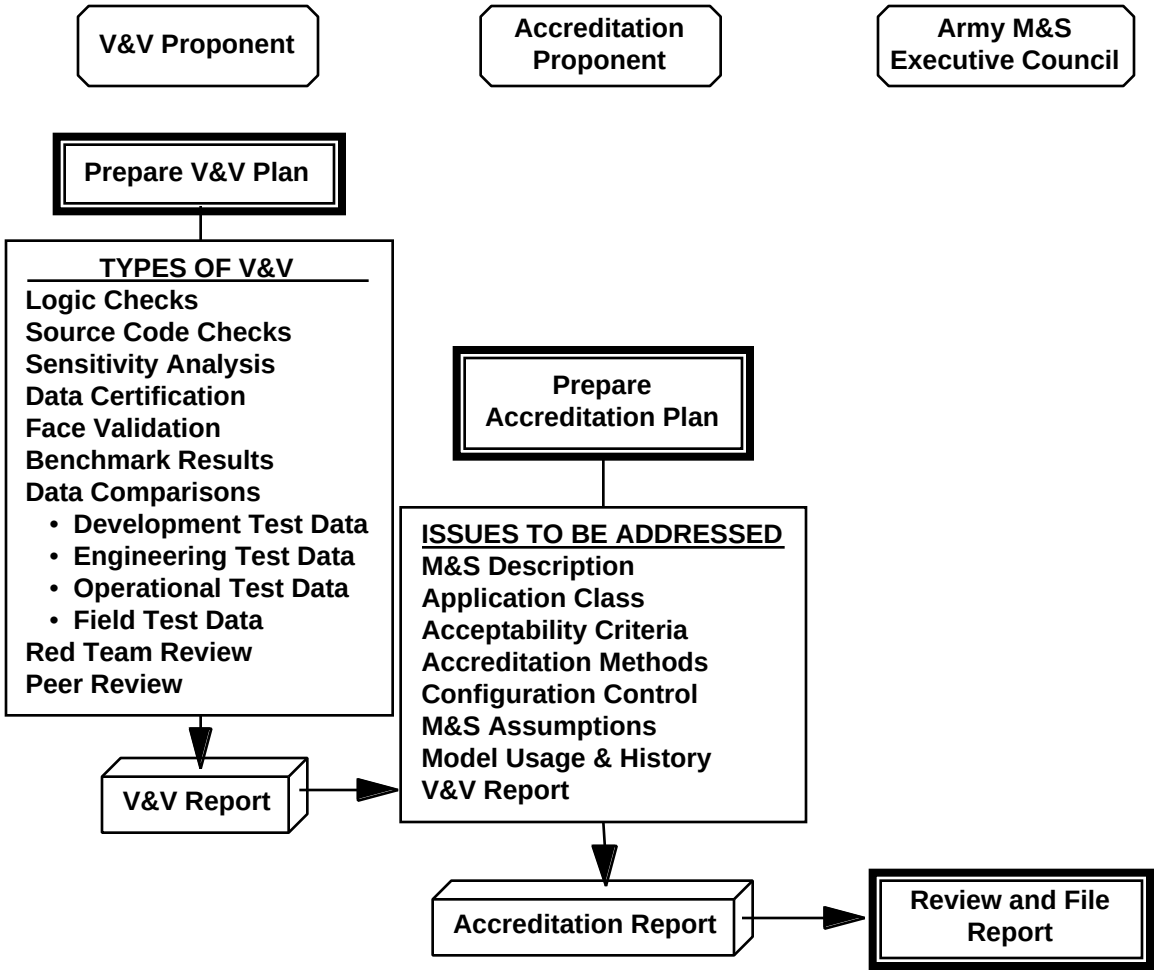

FIGURE 1 ARMY ACCREDITATION PROCESS (CLASS OF APPLICATIONS)

The accreditation proponent is responsible for developing an accreditation plan in conjunction with the V&V proponent. This accreditation plan identifies the members

of the accreditation team, resources and milestones, documentation required, M/S acceptance criteria, and proposed accreditation methodology.
When the V&V report is completed, the accreditation proponent is responsible for conducting a complete review of the development and use of the M/S, its documentation, the V&V plans, V&V reports, configuration control provisions, M/S assumptions, previous usage, and previous user acceptances. This review is documented in an accreditation report that contains the background, description of the M/S, acceptability criteria, evaluation of the M/S, and any results and recommendations. This review, documented in the accreditation report, serves as the basis for the accreditation decision, which is itself subject to review by the Army Model and Simulation Executive Council (AMSEC).

Besides being accredited for a "Class of Applications," each model must also be accredited for each specific application. This type of accreditation builds on the previous accreditation, particularizing it to the analytical problem for which the model will be used. Figure 2 depicts the accreditation process for specific applications.

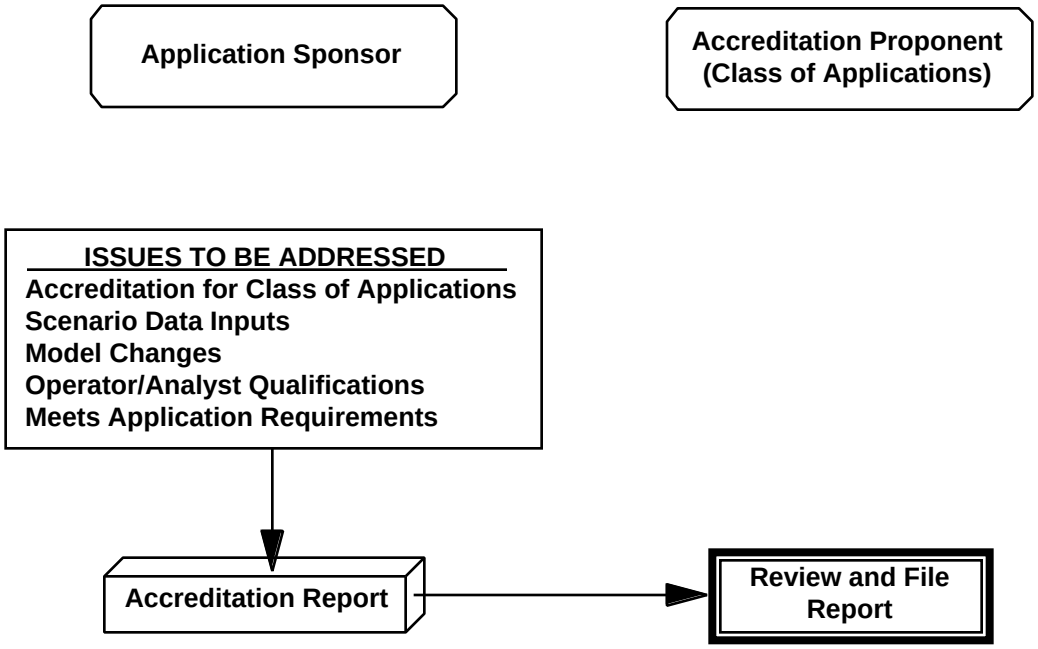

FIGURE 2 ARMY ACCREDITATION PROCESS (SPECIFIC APPLICATION)

The application sponsor (the organization using the model for a specific application) is the accreditation proponent. The sponsor ensures that the model, as modified by scenario, data inputs, or other changes, will provide results that meet the essential needs of the intended use. The application sponsor's review addresses data inputs, scenarios, and operator-analysts who will use the model. The results of this specific accreditation are documented in a brief accreditation report forwarded to the accreditation proponent for that class of applications.

If a model not accredited for a class of applications is proposed for use in a specific application, it must undergo a more rigorous process to be accredited for the specific

application. This rigorous process is tantamount to fulfilling the accreditation requirements for a class of applications as well as for the specific application.
The various VV&A responsibilities are assigned to either the V&V Proponent or the Accreditation Proponent. Assignment of V&V Proponent or Accreditation Proponent responsibilities depends on the stage of M/S development. During model development, the agency responsible for that development is typically assigned as V&V Proponent. For M/S that are maintained by a single Army agency, that agency is the V&V Proponent. If an M/S is under Army control but has multiple users, the agency chairing the M/S Users Group will be the V&V Proponent. M/S users are typically assigned Accreditation Proponent responsibilities. Table 1 identifies the V&V Proponent and the Accreditation Proponent for specific circumstances.

TABLE 1 ARMY VV&A RESPONSIBILITIES

	V&V Proponent	Accreditation Proponent
Model In Development	Sponsor	N/A
Developed & Used by a Contractor	Sponsor	Sponsor
Used or Maintained by Single Army Agency	User	User
Multiple Users	User's Group Head or Predominant User	Each User for Each Specific Application
Other Service Control, Used in Army or Joint Study	N/A	Army Agency Responsible for Mission/Function Area
Threat M/S	Appropriate Intelligence Agency	Each User for Each Specific Application

4.2 Army Accreditation Policy Features

The Army process entails preparation of five different VV&A plans or reports to obtain accreditation for a specific application. (This assumes that a class accreditation is obtained first.) Because of the nature of the V&V material, these documents will most likely be quite lengthy and costly to prepare. In all likelihood they will not be read by the accreditation authority but will only serve as proof that the model was actually accredited in the event that study results prove inaccurate or unacceptable. One advantage of such in depth reports is that they document V&V results for the benefit of future model users and reduce the likelihood of duplicative efforts.

As indicated in Table 1, Army VV&A responsibilities are typically assigned to the sponsor or user. In most cases the V&V Proponent and the Accreditation Proponent will be from the same activity or command. Therefore, accreditation decisions are made by the agency or activity that either commissions or conducts a study. This feature allows the agency to better coordinate the VV&A plans and to tailor the VV&A requirements to the needs of the study. Keeping the accreditation decision

within the using activity minimizes the cost and time expenditures associated with briefing several external activities for coordination and approval. Army policy includes provisions for the review of application-specific accreditation decisions by the accreditation proponent for a class of applications, and by the AMSEC for accreditation decisions on a class of applications. However, these reviews do not appear to cause any additional briefings or reports.

The advantages of allowing user accreditation lie in the efficiencies that can be achieved. These advantages are exemplified by AMSAA, which has accredited at least two different models under the guidelines of this regulation. Since the accreditation authority is the director of AMSAA, the V&V results were provided to the director in a formal briefing and the annotated briefing materials served as both the V&V and the Accreditation Report. This documentation practice saved considerable money and time that otherwise would have been spent in preparing a more formal report.

In addition to spelling out the process to be followed and the responsibilities of each proponent in satisfying accreditation requirements, AR 5-11 also identifies the types of information that should be used to justify model accreditation. This information is amplified in the pamphlet, DA PAM 5-11, which also gives examples of acceptability criteria that might be used in judging model suitability. By identifying typical information needs and giving examples of acceptance criteria, the Army guidelines help provide uniformity in accreditation decisions. Acceptance criteria were frequently mentioned as one of the key requirements to accredit a model for an application. The list of sample acceptance criteria provided in DA PAM 5-11 is particularly useful since this is the only document found which provides such an example. The Army examples of acceptance criteria are listed in Appendix E.

4.3 Navy Accreditation Policy Description

The Navy guidelines for M/S accreditation are promulgated in a draft OPNAVINST titled "Verification, Validation, and Accreditation (VV&A) of Navy Models and Simulations" dated 7 October 1993. This document is supplemented by another draft document titled “Principles of VV&A of Navy Managed M/S” dated 1 October 1993. These documents have been circulated for comment and are subject to change. However, they do reflect the current Navy thinking regarding M/S accreditation. The policies expressed in these documents will be used herein as an indicator of probable Navy direction in this area.

Like the Army regulation, these documents focus on the process for model accreditation. In the proposed Navy process, an M/S Proponent is responsible for preparing and/or collecting information on the model and associated V&V. An independent official, appointed by the Navy Model and Simulation Management Office (NMSO), is responsible for certifying the acceptability of the V&V data. Based on this certification, the senior management official responsible for decisions derived from model use accredits the model. The process is depicted in Figure 3.

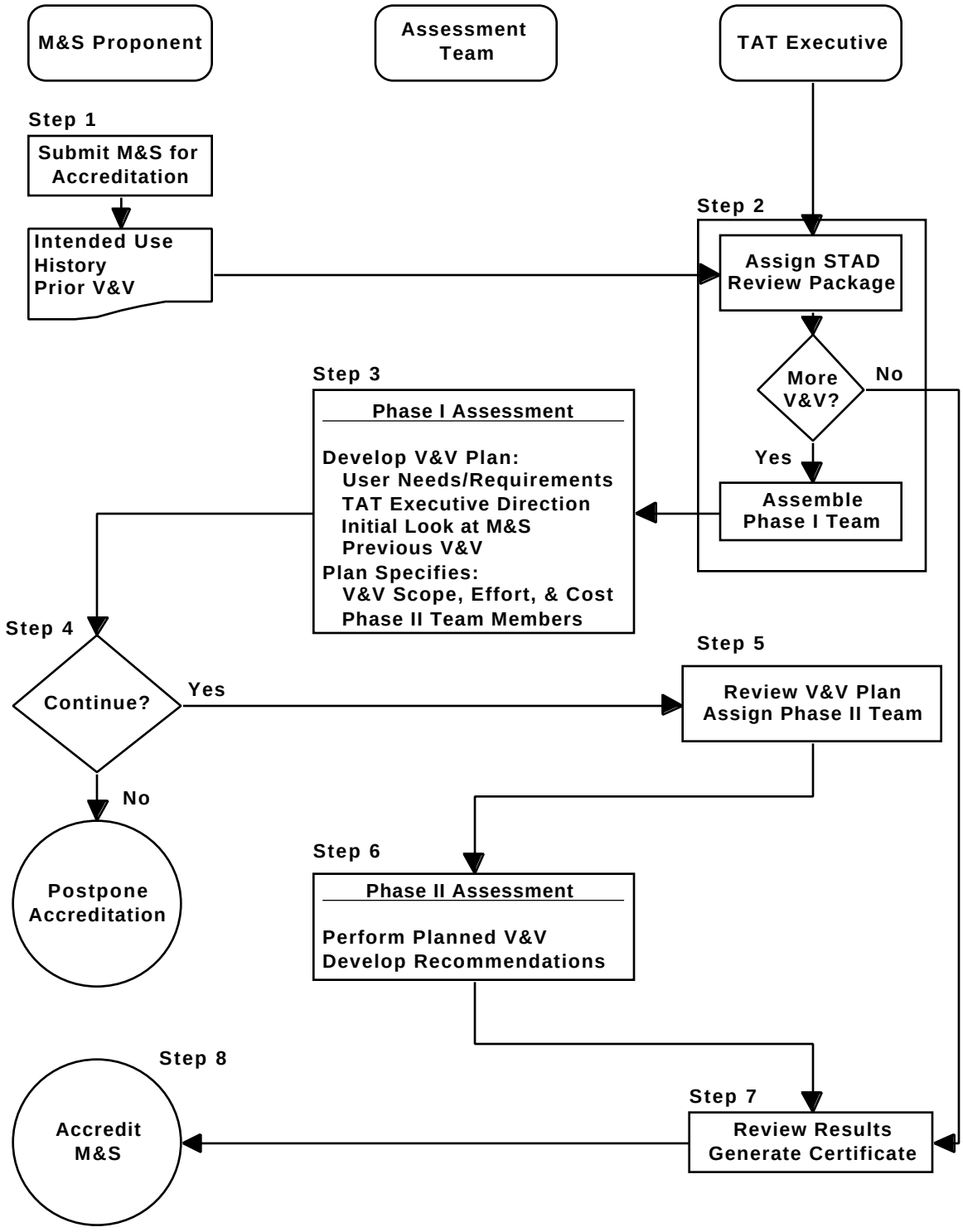

FIGURE 3 NAVY VV&A PROCESS FOR MATURE M/S

The M/S Proponent (the organization seeking the accreditation) initiates the process by assembling and submitting to NMSO information on design specifications and requirements, intended use(s), history, background, and prior V&V. The NMSO head, also referred to as the Technical Assistance Team (TAT) Executive, appoints

a Senior Technical Assistance Director (STAD) from the TAT to guide the initial review of the material submitted by the proponent. This review results in either a V&V certification or a recommendation for additional V&V. If further V&V is to be performed, the STAD assembles a Phase I assessment team from a body of M/S experts. The team develops a V&V plan based on the intended use, user requirements, model features, and TAT Executive direction. The plan includes actual V&V procedures to be employed and recommendations for membership on the Phase II review team.

The M/S Proponent reviews the plan, especially the funding requirements, and determines whether to proceed or postpone accreditation. If the plan is to be executed, the proponent provides the necessary funding. The TAT Executive assembles the Phase II team, which implement the V&V plan. The Phase II team forwards the results, along with a recommendation, to the TAT Executive, who prepares a V&V certification. This is passed to the M/S Proponent who accredits the model. The draft guidance does not address the issue or possible impacts of a decision to postpone accreditation.

The draft Navy instruction also states that V&V should be made an integral part of M/S development, thus simplifying the VV&A process by providing crucial information early in the development cycle. The supplemental "Principles" document describes how V&V should be performed and documented in parallel with model development to produce an accreditation package. Figure 4 depicts the concept for integrating VV&A with M/S development. In this concept, the M/S Proponent ensures that the product of each step in the development is checked with the previous products to ensure accuracy. The results of this comparison or check are documented. This collection of documented V&V results is reviewed by the TAT Executive, identified in Figure 3. If the documentation is sufficient, the TAT Executive issues a V&V certification, which serves as the basis for accreditation.

Just as in the Army process, a Navy model can be accredited for either a specific application or a "domain" of applications, which is equivalent to the Army's "class of applications." Unlike AR 5-11, domain accreditation is not a prerequisite for application-specific accreditation; however, it will usually facilitate such an accreditation.

The supplementary Navy document, "Principles of VV&A of Navy Managed Models," defines four different levels of accreditation; each level varying in the depth of V&V required for accreditation. The determination of accreditation level is dependent on a trade-off between the level of risk in using possibly inaccurate results versus the cost of accreditation at a higher level. The requirements for each level of accreditation assume the completion of all elements specified for lower levels. The M/S Proponent recommends (and the TAT Executive approves) the level of accreditation required. The VV&A information requirements for each level are shown in Table 2. The description of each level contained in the principles document are summarized in the following paragraphs.

Level 1 accreditation establishes and documents a model's development and enhancement history, summarizes past applications, documents V&V status, and

defines its application domain based on a description of the capabilities prepared by the model developer.

Level 2 accreditation is based on an examination of M/S assumptions, algorithms, architecture, implementation, development and enhancement history, past and intended applications, and past VV&A efforts. In some cases, portions of the software code may be verified independently by a review team, and some test cases run.

Level 3 accreditation is based on the validation of M/S application results. It requires correlation of M/S results with all known data about behavior of the subject modeled.

Level 4 accreditation implies extraordinary efforts to assure accuracy and reliability in M/S applications. It provides assurance that a model performs acceptably for interaction that leads directly to the control and movement of real systems in real time. This level of accreditation may also be appropriate for other M/S whose accuracy is essential for human safety.

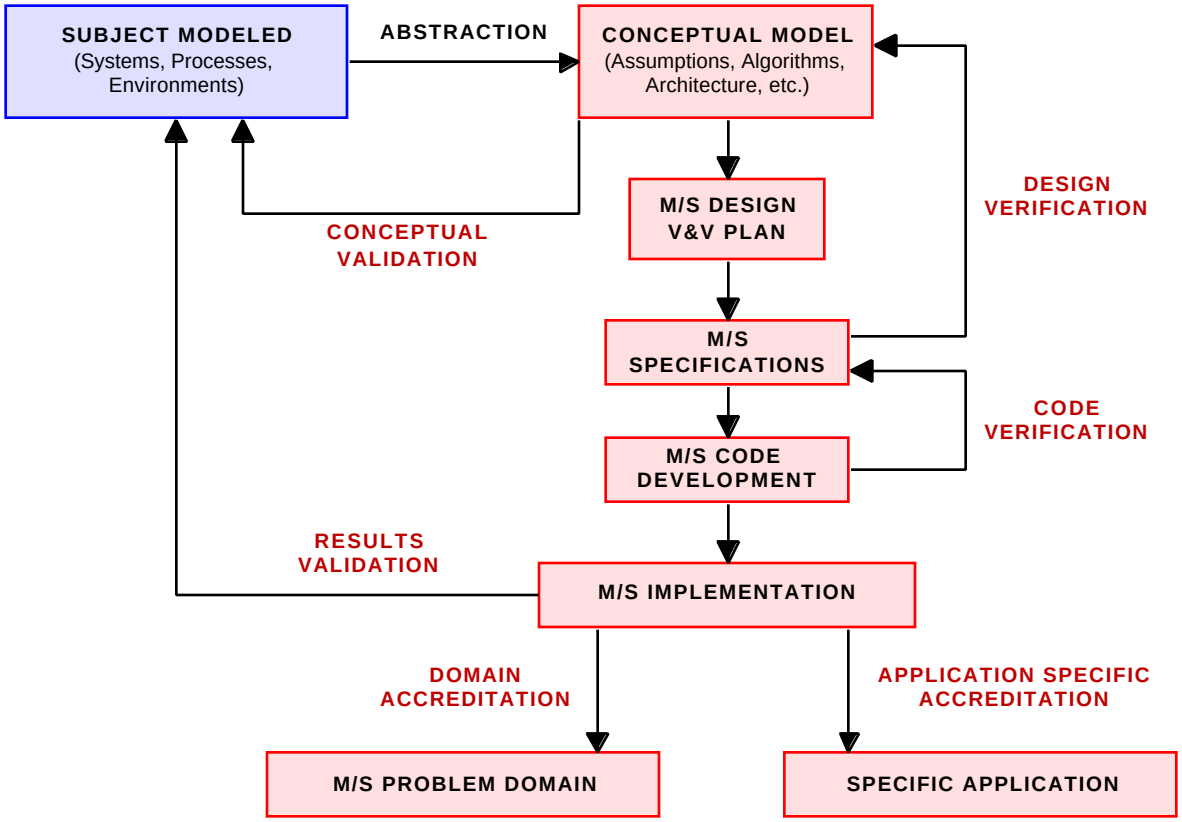

FIGURE 4 NAVY VV&A PROCESS FOR MODELS IN DEVELOPMENT

4.4 Navy Accreditation Policy Features

The proposed Navy instruction does not include a requirement, nor does it discuss a need, to define and establish acceptance criteria by which to judge whether a model is suitable for use in a particular application. The draft instruction does require a

TAT, led by a STAD, to review and certify that model V&V results are satisfactory. To do this the TAT must study the particular application, including the measures of performance (MOPs) or measures of effectiveness (MOEs), derive a set of acceptability criteria, evaluate whether a model meets those criteria, and determine if a model has had sufficient V&V to assure that it can be reliably used within the envelope of the intended application. To perform these functions, the TAT and STAD require an understanding of the intended application and any related factors that might affect development of acceptance criteria. They also need a high degree of M/S technical knowledge to translate an application's MOEs/MOPs into a reasonable set of M/S acceptance criteria and to assess whether a model, its operating limitations, and its V&V results meet those criteria. Nevertheless, the critical relationship between study MOEs/MOPs and M/S acceptance criteria is left unexplained in the draft instruction.

TABLE 2 INFORMATION REQUIREMENTS BY ACCREDITATION LEVELS

Requirement	Accreditation Level			
	1	2	3	4
M/S history, intended use, V&V status, capabilities	x	x	x	x
User's Guide	x	x	x	x
Software Design Documents & Programmer's Manual		x	x	x
Analyst's Manual			x	x
Summary of M/S assumptions, algorithms, architecture, and available input data		x	x	x
Verification plan	x	x	x	x
Documented results of verification tests		x	x	x
Independent verification reviews and tests			x	x
Face validation		x	x	x
Comparisons with real world data			x	x
Configuration management version tracking & archiving	x	x	x	x
Configuration management plan			x	x
Tracking of Software Trouble Reports and Change Requests			x	x
Configuration management board constituted				x
Input data validity			x	x
Users and analysts trained			x	x
User groups established				x
User certification				x

The proposed instruction does not define the requirements for membership on the TAT or for selection as a STAD. Membership on the TAT will probably be selected by the TAT Executive, possibly assisted by various technical advisors. Recognizing that the TAT Executive position will usually be filled by a commissioned officer, and that periodic rotation of these officers will occur, there is no assurance that the TAT Executive will always have adequate M/S expertise to select the best personnel with both M/S and subject matter knowledge to serve on the TAT. Furthermore, considering the broad scope of potential applications, it would seem nearly impossible to create a standing team of M/S experts who collectively have sufficiently broad knowledge of potential applications. Consequently, the quality of decisions affecting model accreditation will likely be inconsistent.

Another result of the lack of acceptance criteria, or a guide for developing them, is the potential for using a model outside the envelope in which the V&V results apply. Comparisons between model outcomes and real world results are made under specific environmental conditions. If the model outcomes and the real world results are closely related at one or more specific points, it is an indication that the model can yield valid, real world predictions at other points in the environment. However, there is usually a boundary beyond which the accuracy of these predictions becomes suspect. TAT members will be required to recognize these boundary conditions and assess the extent to which V&V results can be considered reliable. In addition, the TAT members will also be required to determine the envelope of the intended application and compare it to the V&V boundaries. This is a tall technical order, especially for a team whose members are not eminently familiar with the study and its objectives.

The TAT and STAD, lacking guidance on acceptance criteria, will be motivated to ensure that they will not be criticized for recommending accreditation without sufficient V&V. Consequently, they will have a tendency to be overly cautious and require more V&V than might be necessary if clear acceptance criteria were established. This tendency will be unchecked, since the TAT and STAD have no explicit fiscal responsibility for performing the V&V as the instruction is now written. If members of the TAT belong to a parent organization that might be tasked to perform the V&V, there could be additional motivation to amplify V&V requirements to obtain additional funding for their parent organization.

Another possible impact of the proposed Navy process is an expanding requirement for intermediate briefs and reviews of accreditation proposals. If the STAD and TAT evolve into an apparent extension of N81, and the organization preparing an accreditation package is organizationally separated by several layers, numerous intermediate reviews of the accreditation package could be required. These reviews and possible revisions of the package could cost additional money and time beyond that required solely by the draft instruction.

The proposed Navy process addresses the desirability of performing V&V in parallel with model development as new models are created. Although the extent of such V&V is not described fully, it will probably yield a set of documents that provide information on the model's assumptions, limitations, conceptual description, verification test results, any desk check results and validation results. In no way can

the newly developed model be certified by the TAT until the application is known and a set of acceptance criteria developed. If the TAT attempts to certify a model without knowing the intended application and associated acceptance criteria, they will have a tendency to seek near perfect correlation between the model and test data. This tendency would tend to force the cost of model development to be greater than necessary. Even if they obtained extensive validation results, a critical element of the application might be overlooked and the model might not meet all the required acceptance criteria. In such a case, model usage might lead to invalid study predictions or conclusions.

The four different levels of accreditation defined in the supplementary document on VV&A principles have different VV&A requirements. The document does not provide any guidelines for correlating the accreditation levels, the degree of acceptable risk, the potential impacts of the model employment, and the information needed to support accreditation at each level. Without such guidelines, the mere definition of different accreditation levels can lead to confusion in defining acceptance criteria for each application.

4.5 Air Force Accreditation Policy Description

The Air Force is in the process of developing a policy governing VV&A of models and simulations. A draft document dated 25 October 1993 outlines the emerging Air Force policy concepts governing M/S VV&A. Certainly, the details of the VV&A process may change. However, the basic concepts are expected to form the basis of the final policy that is implemented.

The emerging Air Force policy defines eight criteria against which a model can be compared. Using these criteria, M/S used in Air Force studies are categorized into three groups. The principle criteria for placing an M/S into one of the three groups are completeness of documentation and community acceptance as indicated by the extent of completed accreditation. According to the draft policy this categorization provides an integrated priority list (IPL) so that M/S in category I will undergo VV&A prior to category II and category III. Category II models will undergo VV&A prior to category III. Of the five SMART models, ESAMS and RADGUNS fall into category I, ALARM is in category II, AASPEM is in category III, and TRAP is not included.

The Air Force VV&A process, depicted in Figure 5, begins with a determination of the level of V&V that is required. This determination is made by a committee composed of accreditation proponents (model users), model developers, configuration and V&V managers, and an AF/XOM representative. The committee decides on a V&V approach, estimates the funding required, and estimates the personnel required. If sufficient documentation does not exist, a minimum set of documents must be developed before completing the V&V effort.

Once the V&V requirements are defined, the accreditation proponent implements the recommendations of the committee. The committee reconvenes upon completion of the V&V effort to review results and compare the amount of V&V done to the original plan. They provide an independent technical assessment of the model, a comparison to the actual versus planned V&V, and a statement of risks if a portion of

the V&V process was omitted. These committee findings are used by each accrediting official to support accreditation of the model for each particular application.

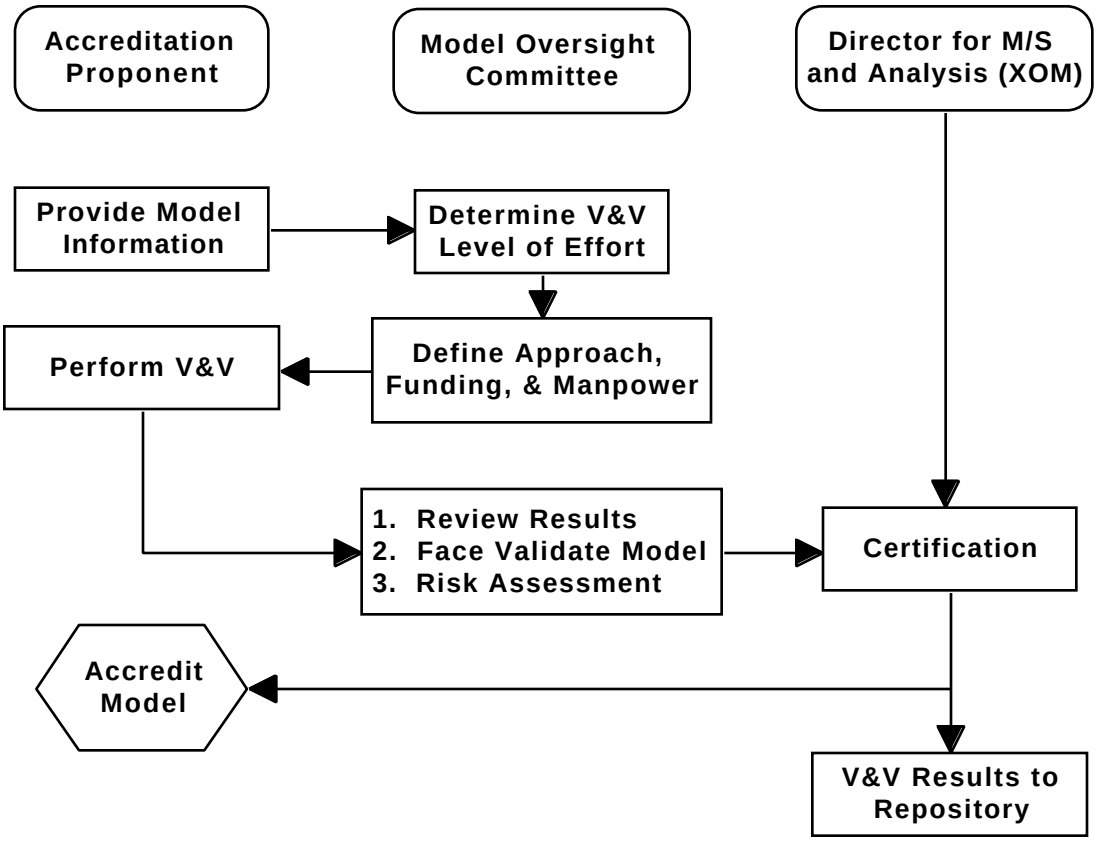

FIGURE 5 AIR FORCE VV&A PROCESS

According to Air Force policy, each M/S will have a single V&V focal point to coordinate current V&V activities and to serve as a repository for information gathered from previous V&V efforts.

4.6 Air Force Accreditation Policy Features

The Air Force process is simpler than either the Army or Navy processes. There is no defined requirement for special reports to document VV&A plans or reports.

The major shortcoming of the Air Force process is the lack of guidance on the criteria that should be used to determine the amount of V&V required. Without this guidance, each committee will base their recommendations on their own subjective judgment. Under these conditions, there is a greater likelihood that unnecessary V&V might be required to ensure that the committee will not be criticized for recommending a model for accreditation when it doesn't adequately represent the real world. Some guidance is needed on how acceptance criteria should be developed and used to define V&V requirements.

A second, albeit less severe, shortcoming of the Air Force policy is the requirement to make decisions by committee. The time and effort required to constitute, convene and reconvene several committees for the review of several M/S will demand significant resources. Additionally, the problems of getting key officials to devote sufficient time to these committee duties and to actually evaluate model V&V results can lead to committee member substitutions and lack of continuity from one phase to the next. Such personnel changes can result in additional work to satisfy changing V&V requirements.

The Air Force concept of categorizing M/S into an integrated priority list (IPL) for VV&A implies that once a model has undergone the prioritized VV&A and has received XOM certification it is suitable for use in all Air Force studies. If this perception is valid, the Air Force philosophy differs from the other two services and from the M/S community in which accreditation must be performed for each application. The other two services have stated that domain or class of application accreditation is not, by itself, sufficient for application specific accreditation.

4.7 J-MASS VV&A Policy Description

Besides the three services, the J-MASS program has drafted a set of VV&A guidelines that are intended for use on the threat models developed under their program. Since the J-MASS architecture will be used for development of new M/S, and the SMART products should support VV&A of future models as well as current ones, the J-MASS VV&A guidelines were analyzed as part of this study.

The draft J-MASS guidelines are based on the principle that V&V is done concurrently with model development. Accreditation is recognized as being done after model development is complete and a specific purpose has been identified for the model's use. The J-MASS VV&A process is diagrammed in Figure 6.

The J-MASS process is based on MIL-STD-2167A requirements and is similar to the V&V process described in the Navy guidelines for V&V of new models. The unique aspect of the J-MASS process is that it focuses on verification and validation of modeled threat systems; the J-MASS V&V process does not address the other aspects of the models such as target algorithms, environmental features, blue force systems, etc. The V&V results are reviewed by the Defense Intelligence Agency (DIA) or its designee. The purpose of J-MASS V&V, including DIA review, is to ensure that the models accurately represent real-world threat system performance.

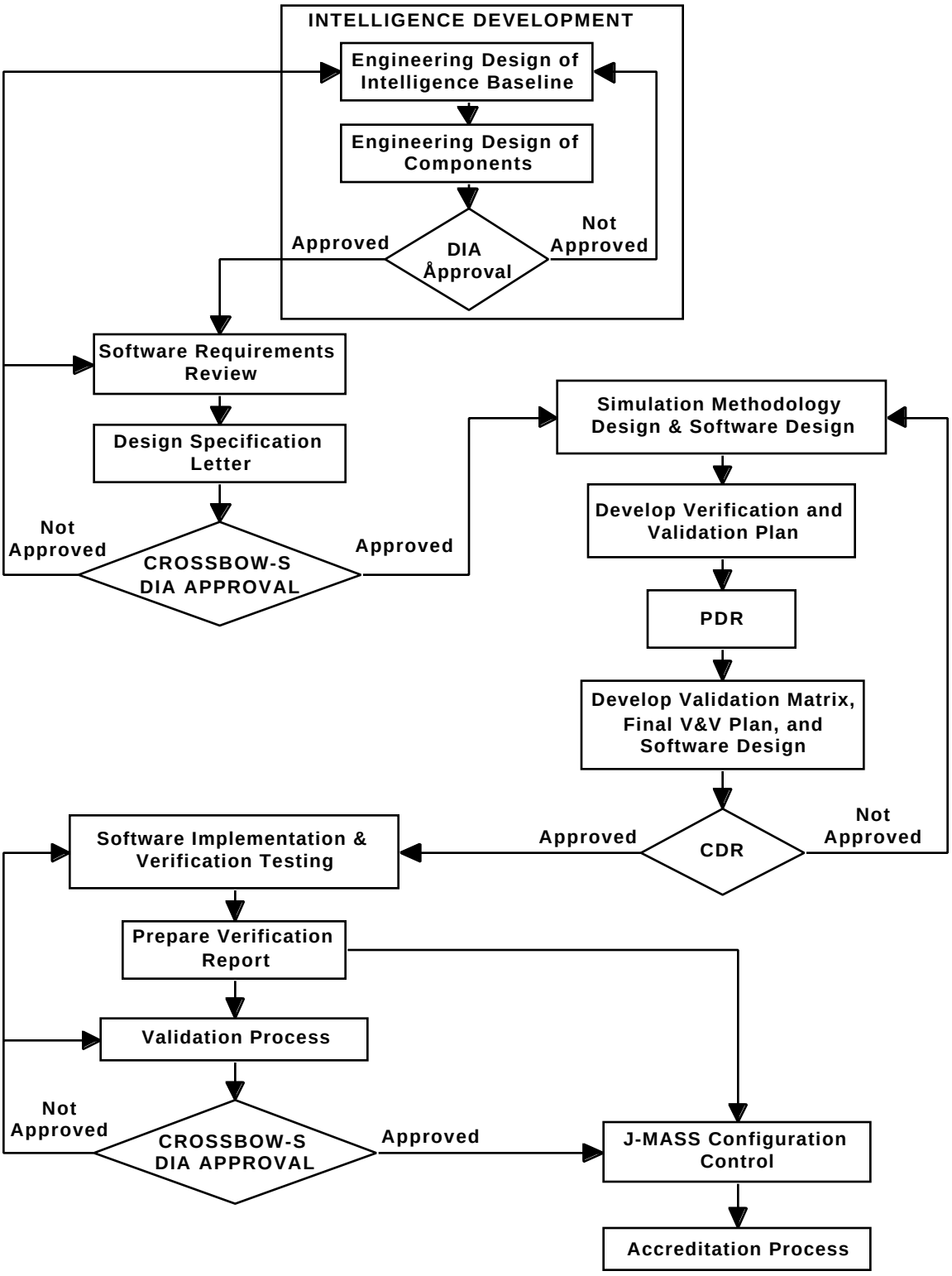

FIGURE 6 J-MASS VV&A PROCESS

The J-MASS verification process is performed by a verification team that reports to the responsible approval authority, who is generally the program manager for a given model development effort. Verification involves:

- reviews of model requirements to ensure compatibility with an intelligence baseline;
- reviews of the engineering design, software design, and test plan for completeness and consistency with J-MASS standards;
- reviews of software coding and testing for elements, assemblies, player level components, and external interfaces to ensure completeness, correctness, and consistency with J-MASS standards;
- reviews of model documentation, including the Model Requirements Documentation Manual, to ensure that it is complete, correct, consistent and a suitable baseline for succeeding software development activities;
- reviews of Software Test Plans and Test Descriptions to ensure that these tests demonstrate all system and software requirements, boundary condition coverage, and input/output condition coverage;
- reviews of the validation matrix to avoid duplication of effort;
- determination that internal configuration control is maintained and adequate records of test results are maintained;
- preparation of the verification report.

The J-MASS validation effort is focused on development of two documents: the Design Specification Letter (DSL) and the Model Validation Report (MVR). The DSL documents the model specification to ensure the threat baseline will support simulator development. It also documents any differences between the threat data and the specification. The MVR documents the comparison between the threat and the model.

The validation effort encompasses the following steps:

- reviews of the Threat Definition Document to ensure that it addresses all applicable threat characteristics;
- preparation of a validation matrix, a minimum set of validation criteria, and a list of planned tests to sufficiently stress the model without excessive dedicated testing
- comparison of model test data with the threat baseline to determine degree of correlation;
- preparation of the MVR to document comparison results.

Both the draft DSL and the draft MVR are sent to the model developer for comments and possible model revisions. When finalized, the DSL and MVR are sent through the appropriate service channels to the Chairman of the Validation Subcommittee of the CROSSBOW-S Committee. The subcommittee reviews the validation reports and develops a recommendation for approval or additional development/validation work. These recommendations are passed to the CROSSBOW-S committee, which reviews them and passes the reports to the DoD Executive Committee on Threat Simulators (EXCOM). Upon recommendation of the CROSSBOW-S committee, the EXCOM chairman will generally approve the validation report. If there is any

disagreement between the service and the CROSSBOW-S committee, the EXCOM will meet to determine what action should be taken.

The accreditation effort closely parallels the validation effort. The user requirements are determined and compared with the validation report results to determine if they are completely addressed. If not, an accreditation matrix, incorporating the latest intelligence data, is developed. Additional validation is performed, and the results compared to the requirements. The results are reported in an accreditation report that is presumably sent to the accrediting authority. Figure 7 shows the accreditation process for a given application once the V&V has been completed.

4.8 J-MASS VV&A Policy Features

As indicated in the discussion above, both verification and validation are performed by a team that is independent of the model developer. The verification tests and validation matrix are coordinated to eliminate duplication where possible. These features contribute to V&V efficiency. The verification results are reported to the program manager and the developer through “quick look” and draft reports. This closely coordinated relationship is beneficial in that the verification results are reviewed and acted upon with a minimum of excess paperwork and reviews by intervening management layers.

In contrast to the verification process, the validation report receives multiple reviews outside the developing organization. In fact, the J-MASS process requires that the validation reports be passed to the CROSSBOW-S committee and the EXCOM through the services. Therefore, the intermediate reviewers can require repeated report modifications and/or additional validation work to be accomplished before ever having the report reviewed by the approving authority. This feature can result in unnecessary and excessive work.

Another aspect of requiring CROSSBOW-S and EXCOM approval of the validation report is the perception that they are determining if a model is suitable for use. The validation report describes the degree of correlation between the model and the DIA baseline data. When EXCOM approves the validation report, they must use their own criteria for judging acceptability. If they do not know the actual accreditation requirements, it is likely that they would err on the conservative side and use excessively demanding acceptance criteria to avoid criticism. Such requirements could possibly result in extensive work to develop a model that has a very high degree of correlation with the threat. This effort may be unnecessary since the accreditation authority establishes the acceptance criteria for each intended application and these criteria may not be as demanding as that set by EXCOM.

The J-MASS V&V process focuses on threat systems. Other aspects of the model are not addressed in the draft guidelines. Even if the process is followed exactly, and EXCOM approval is granted, a model user will probably need to perform additional V&V on the parts of the model that represent blue systems and environmental features.

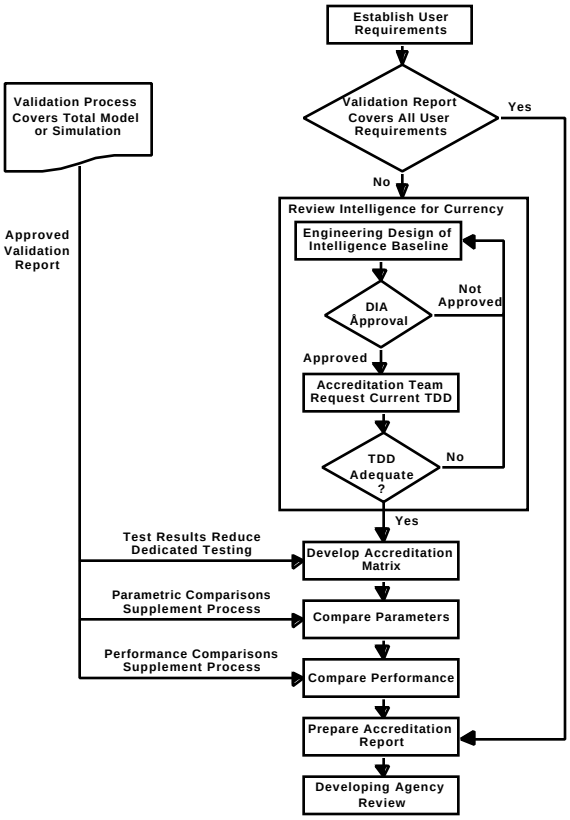

FIGURE 7 J-MASS ACCREDITATION PROCESS

5. ANALYSIS OF ACCREDITATION PRACTICES

Although the Army has a formal regulation in place that defines the procedures for accrediting M/S, and the other services are developing similar policies, our interview results indicate that the organizations actually using M/S do not conform to the details of these established or emerging policies in most cases. Many M/S users consider VV&A as part of the overall study process, and integrate VV&A efforts within the context of the total study. The actual practice of performing a study while concurrently building model credibility is described in the following paragraphs.

5.1 Typical Accreditation Practices

In analyzing the information in the interview summaries, some similarities emerged regarding the practices used by the different organizations to select, accredit, and employ a model in a particular study application. Considering these similarities, the varying practices can be classified into three typical types: an informal procedure, a semi-formal procedure, and a formal procedure. To compare and contrast these various practices, some common terms were needed to represent various officials in the different organizations. The first common term is the study agent. This official establishes study requirements and directs its accomplishment. Typically, the study agent might be a program manager or the head of a study agency (such as AFSAA or CNA) which is tasked by some higher echelon organization to perform a study. The study team leader is the senior analyst who directs a team of analysts in conducting the actual study.

The first, and simplest, of the three typical practices is the informal procedure depicted in Figure 8. This procedure is usually employed by organizations that have the following common characteristics: 1) they are staffed with experienced analysts; 2) they are routinely and repeatedly tasked to perform COEAs or other similar studies in support of acquisition decisions; and 3) their study results are frequently needed in a short time. The major feature of this informal practice is the significant level of responsibility placed on the study team leader. The team leader has almost complete autonomy in selecting the model, finding and validating data, modifying the model, and determining that the model will yield credible results for the problem at hand. The team leader reviews the study product and, if the results appear reasonable, passes them along to the study agent who commissioned the study.

The next typical practice is generally used in those studies where more time is available and/or greater DoD visibility is expected. In this semi-formal procedure, depicted in Figure 9, the study team performs essentially the same steps as are performed in the informal procedure. The only difference is that the study agent has an opportunity to review and approve the study plan. This study plan, which usually outlines the proposed steps for building model credibility, is submitted after tentative model selection and identification of valid source data. Once the plan is approved, the study team completes the planned steps as shown in the diagram. If required by the study plan, a formal V&V report is prepared.

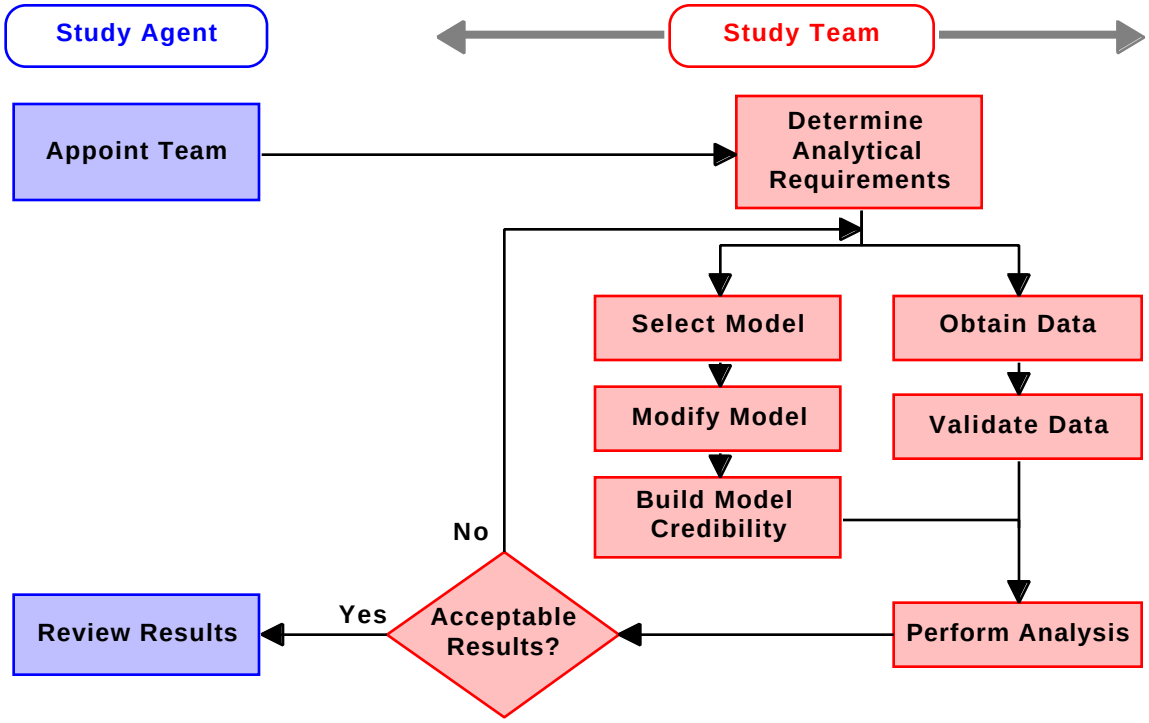

FIGURE 8 INFORMAL PROCEDURE

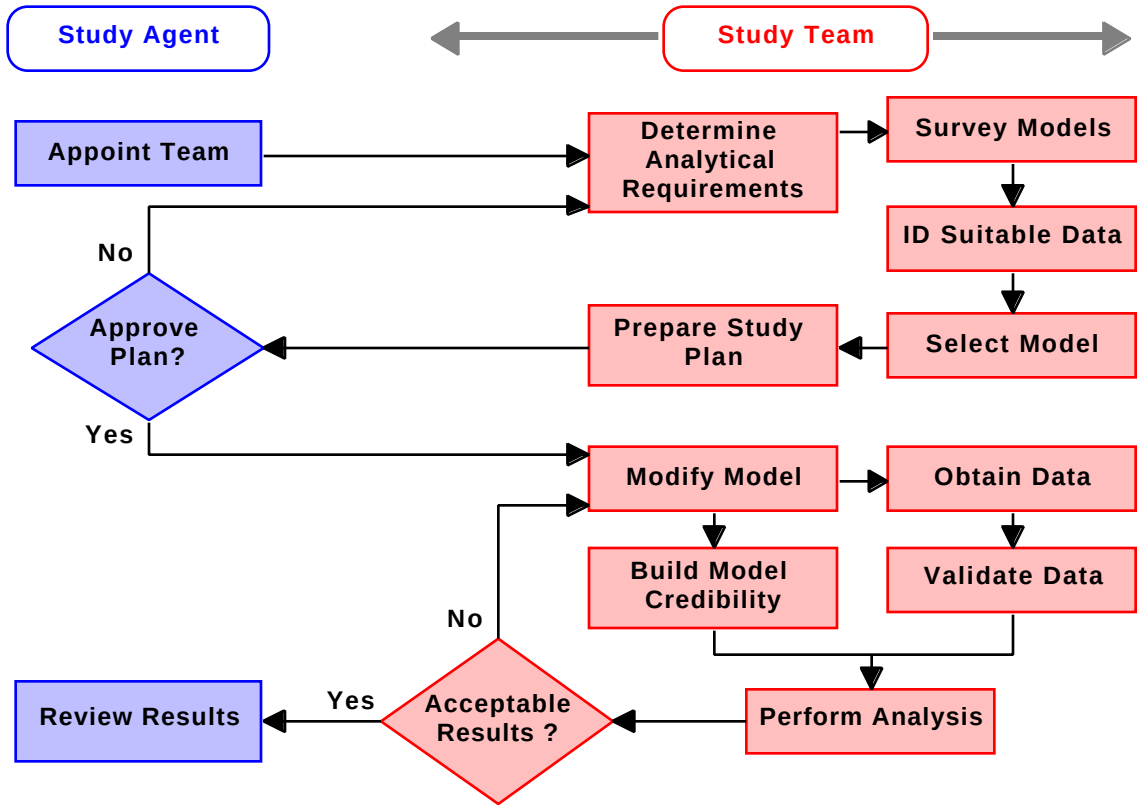

FIGURE 9 SEMI-FORMAL PROCEDURE

The formal procedure is typically employed by those organizations governed by an approved VV&A policy document, either local or service wide. This procedure, depicted in Figure 10, is more structured and includes a formal model accreditation step. The study agent has the opportunity to approve the overall study plan and also to accredit the model based on a formal V&V review. However, due to time constraints usually experienced in most studies, model V&V typically takes place in parallel with the actual study. The formal accreditation is often accomplished just before, or concurrent with, the completion of the study. This concurrency forces a close coordination between the V&V effort and the study effort, so that any model deficiencies that might be uncovered in the V&V process are properly corrected before the final study results are produced.

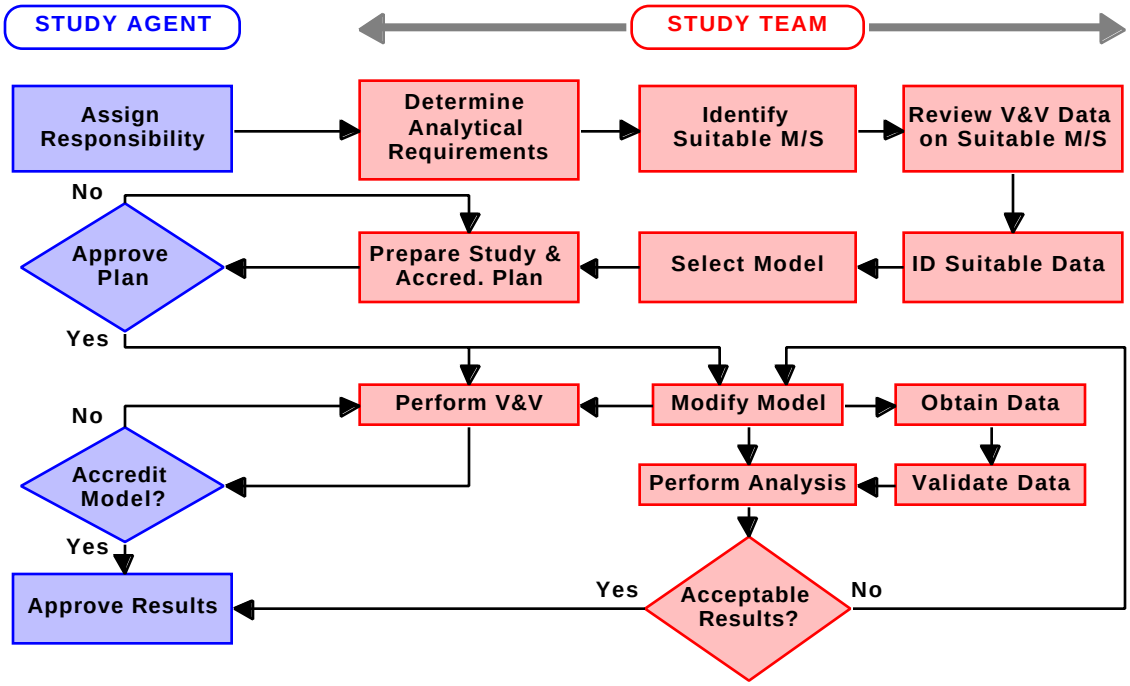

FIGURE 10 FORMAL PROCEDURE

The activities that employ one or another of the above procedures are identified in Table 3. Some correlation was noted between the type of agency or activity and the level of formality in the practices they employ. The army has promulgated a policy requiring formal accreditation. Therefore, army agencies tend to employ a formal procedure. Other agencies are governed by local policies and practices that have evolved through usage.

Study agencies such as AFSAA and CNA, having highly qualified analysts who frequently perform short term studies, typically use the informal procedure. AMSAA is an exception. In accordance with AR 5-11, they formally accredit those models that they normally use.

The two acquisition programs included in this investigation follow different practices according to the individual program manager's guidelines. The Tomahawk Program Office recently issued an instruction requiring a formal accreditation for all M/S used in the Tomahawk program. However, the instruction is so new that formal accreditation procedures are not yet in place. Until now, they have followed the informal practice. The Advanced Strategic and Tactical Expendables (ASTE) project undertook a formal, independent V&V of their simulation in an attempt to accredit it. Those V&V results are not yet available, and the efficiency of that process cannot be evaluated.

TABLE 3 ACTIVITIES USING TYPICAL PROCEDURES

TYPE OF ORGANIZATION	INFORMAL PROCESS	SEMI-FORMAL PROCESS	FORMAL PROCESS
Study Agencies	CNA AFSAA		AMSAA
Program Managers	PMA-281		ASTE
Operational Test Organizations			OPTEC OPTEVFOR AFOTEC
Headquarters Organizations	ASC ADC SOPS (1)	NAVAIR-526 ADC SOPS ASC (2)	

(1) ADC SOPS uses this procedure only if time constraints dictate.
(2) ASC uses this procedure for large and complex studies.

All three OT organizations formally accredit their models. OPTEC complies with AR 5-11. AFOTEC has a command instruction requiring model accreditation. OPTEVFOR has established an M/S division and is increasing its staff to perform formal accreditations. In the meantime, they have requested CNA to accredit models for OPTEVFOR use. It was noted that these models are not accredited for a specific purpose, but for operational evaluation in general. CNA (not OPTEVFOR) develops the acceptance criteria for judging model suitability.

The last group of organizations, the Air Force ASC, NAVAIR 526, and ADC SOPS, follow either informal or semi-formal practices. NAVAIR 526 nearly always submits an analysis plan for approval before beginning a study. The only exception is when a very short term study is needed. The other two organizations follow either process depending on the time available and the expected visibility of the results. As described in the applicable interview reports, these organizations generally perform COEAs much shorter in duration than studies performed by the analysis and operational testing activities. Therefore, they seldom have the time to accredit their models for each application.

5.2 Features of the Typical Practices

Our analysis shows that organizations with similar missions tend to adopt similar VV&A practices. The OT organizations, motivated by a desire to substantiate conclusions about a system under test, all strive to ensure that M/S results are sound: they usually follow the formal VV&A procedure. The study agencies, having extensive M/S experience, trust their analysts to be the best judges of model credibility. They typically employ the informal procedure. AMSAA is the exception. Guided by AR 5-11, they have switched to using the formal procedure. Even so, they maintain a balance between resource demands and the degree of VV&A formality. They make extensive use of briefings and annotated briefing charts to avoid the cost and time associated with the preparation and review of formal report documents. The remainder of the organizations, unless driven by an established policy, balance the need for VV&A formality with resource constraints. As indicated

in Table 3, organizations including ASC and ADC SOPS will choose between different levels of formality depending on the potential visibility of the study results.

Many of those surveyed in this study had common concerns regarding VV&A costs and time requirements. The CNA and NAVAIR-526 representatives expressed reservations about the formal VV&A process being considered by the Navy. They felt that it would be far too costly and time consuming. Mr. Clayton Thomas of AFSAA stated that the planned Air Force policy should be as "permissive as the traffic will bear under the current DoD guidelines" and GAO interest. He also recognized that time constraints sometimes force the use of models that are not totally suitable. These statements are consistent with the observations that most organizations involved in performing studies use processes that are much less formal than those described in service level instructions and regulations. Clearly, the major feature of the typical processes is the balance between resource constraints and the level of VV&A formality.

Some activities, though concerned about M/S validity and study credibility, felt that competent analysts who deal with M/S on a regular basis are best suited to judge if a particular M/S is acceptable for a particular application. Even if a formal review process is followed for approving a study plan or for accrediting a model, the study analyst has primary responsibility for generating the required information and presenting it to the reviewing official. It was recognized that an analyst's judgment on M/S suitability can be affected by several factors, including: 1) schedule constraints; 2) a possible lack of models that meet study requirements; or 3) individual biases of the analysts toward familiar models. In spite of these factors, agencies that routinely perform studies, such as CNA and AFSAA, have groomed a cadre of competent analysts who have merited the confidence of their superiors. In at least one example, their competence is recognized outside their own organization. OPTEVFOR enlists the services of CNA to perform V&V on the models which OPTEVFOR uses. This tasking results from OPTEVFOR's perception of CNA's credibility in dealing with models.

One common discipline followed by many current analysts is the delineation of acceptance criteria for evaluating model acceptability. AMSAA has included them as a key element of their VV&A checklist. OPTEC personnel stressed the importance of acceptance criteria for accreditations, which are always application specific. The application MOEs or MOPs govern development of the acceptance criteria. The Air Warfare Center interviewee stressed that selection of the MOEs or MOPs is probably the most critical aspect of any study. If improper MOEs or MOPs are selected, the study results can be totally erroneous, even if properly accredited models are used. Appropriate and acceptable MOEs or MOPs are the basis for acceptance criteria definition. These criteria should be used to judge whether a model will be suitable for use in a given study application. These criteria should address the issue of the required fidelity between model predictions and real world results. Such fidelity criteria would then be applied to validation results to judge model acceptability.

Another common feature that characterizes the existing VV&A practices is the requirement to provide specific types of information. Most organizations have

identified the information required to determine whether the model is acceptable. CNA's requirements are focused on verification information, such as results of logic checks of the algorithms, sensitivity analyses' results, and reviews of model assumptions and constraints. AMSAA has a checklist of information elements that are reviewed before accreditation. In contrast, the official Army and Navy policy guidance define formal processes for accreditation but do not specify any required information that must be reviewed. Although these policy documents provide examples of the types of information that can be reviewed, they do not establish any minimum baseline information that must be checked.

6. COMPARISON OF ACCREDITATION POLICIES AND PRACTICES

The accreditation processes defined in the Army, Navy, and J-MASS policy documents appear to be excessively bureaucratic and costly when compared to the current practices. Numerous special documents must be produced and reviewed through a hierarchical chain. The preparation and review of such documentation can lead to multiple revisions, and make these processes time consuming and costly. The draft Air Force policy, while rather simple and less demanding on resources, still requires a committee to determine V&V requirements. Like the other service policies, the draft Air Force policy does not provide any guidance on how the V&V requirements (or model acceptance criteria) should be determined.

A major disadvantage resulting from the lack of uniform guidelines for establishing acceptance criteria is the potential variability in requirements resulting from subjective perceptions. Without uniform guidelines for developing V&V requirements, different reviewing officials can impose and demand V&V to be done to different depths. Consequently, planning and budgeting for the V&V of a model will be extremely difficult unless the model and/or study reviewers are known beforehand and consulted during the planning and budgeting process to determine the expected V&V scope.

The requirement to have a team of technical personnel participate in the VV&A review processes is difficult to implement efficiently. Unless team membership is a full time responsibility, team members will be assigned on a collateral duty basis. Each time a VV&A review or activity is scheduled, all the required personnel must be assembled. If multiple reviews or activities are required as part of the VV&A cycle for a single model for a single acquisition, the same team members will normally be required. This requirement will place additional burdens on team coordinators to schedule the necessary reviews expeditiously and yet obtain full attendance. Policies requiring independent technical reviews of all V&V activities will probably lead to delays in accreditation and to unnecessary costs to schedule and assemble the participants.

The requirements imposed by the Army, Navy, and J-MASS for multiple independent technical reviews of V&V results do not appear justified. The advantage of having independent reviews is to ensure that uniform technical standards are used, and to negate the possibility of participant bias. The drawback is the difficulty of obtaining the "right" reviewers (however defined) and the additional time and cost impacts of orienting team participants and assembling them repeatedly to conduct reviews. However, if a set of acceptance criteria were defined for each application, a journeyman analyst with intellectual honesty could exercise judgment as to whether a model met the criteria or not. To eliminate errors and bias, the results of the comparison could be made available for management review. Thus, the need for multiple independent reviews could be replaced by the less burdensome approach of establishing acceptance criteria for a model and allowing the involved analysts to develop the information about the model for comparison with the criteria. The comparison results could be briefed to the accrediting official as a basis for accreditation.

Another point of comparison is the degree of responsibility placed on the analyst. In contrast to the high degree of confidence placed in the analysts by the organization heads in their current practices, the service and J-MASS policies tend to denigrate the analyst and place more credence in ad hoc, independent teams chartered to perform V&V or review V&V results. The structure and membership of these teams, and the technical requirements for assignment to the teams, are not generally addressed in the instructions. However, because the requirement for independent V&V teams is included in these policy guides, it can be assumed that the policy makers lack confidence in either the technical competence or the integrity of the individual organization's analysts.

The advantage of giving analysts and not independent review teams the responsibility for defining acceptance criteria is best seen in light of bureaucratic psychology. If an independent technical reviewer or review team is responsible for determining V&V adequacy, the study analyst will propose a V&V plan with the more likely goal of obtaining the reviewer's concurrence than the goal of fulfilling objective criteria suited to the study. The plan will most likely be structured to meet all the requirements that were met in the last review that official conducted. Typically, a previously approved V&V plan is found and analyzed, and a new one reflecting the new application is prepared. Little independent thought is given to what unique requirements might exist for the new application. While the extent of the V&V performed may be uniform from one application to the next, there can be no confidence that the unique V&V requirements of each application will be addressed. The pseudo-standard V&V requirements that are carried over from one plan to the next may be either inadequate or excessive when compared to an objective set of requirements derived from the study MOEs and MOPs.

7. SYNTHESIS - NOTIONAL PROCESS DESCRIPTION

Current practices for performing a study are relatively streamlined and efficient. The underlying concept, which involves defining the study MOEs or MOPs, deriving model acceptance criteria, gathering V&V information to compare with the criteria, and accrediting the model based on that comparison, appears well-conceived and

logical. This approach tends to mitigate potential biases by requiring that application specific accreditation criteria be defined before model selection. The major disadvantages noted in these procedures are: 1) an inconsistent application of this approach; 2) the potential biases of the analysts coupled with resource limitations that might cause incomplete data gathering and/or improper comparisons; and 3) a possible lack of uniformity and experience in establishing acceptance criteria for each specific application. Any policies that might be developed to improve the quality of study decisions should be based on the advantages of the current practices but designed to overcome their disadvantages while conserving scarce resources.

Considering these goals, a notional process for accreditation of M/S should have the following features:

- Minimal requirements for VV&A reports unless such reports can be used as a source of information for subsequent accreditation decisions;

- Decentralized decision-making authority to minimize schedule impacts and to permit tradeoffs between risk and cost;

- Focus on quality accreditation decisions by providing a mechanism or methodology to introduce uniformity in establishing comprehensive, tailored acceptance criteria based on study MOEs/MOPs.

A notional process that extracts the best features of both the service policies and the actual practices is depicted in Figure 11. This process addresses the total study evolution, not just the accreditation process. In this process, the study team would analyze the problem at hand, define the MOEs or MOPs, develop the acceptance criteria, and plan the necessary V&V and study activities. The study agent would review the plan, paying close attention to the MOEs/MOPs and acceptance criteria. If in doubt about either's adequacy, a separate team of expert analysts would be available to assist in this review. This expert team would help ensure that proper MOEs or MOPs were selected and a complete set of acceptance criteria had been defined. The team of expert analysts could be chartered by either DoD or the individual services.

The primary benefits of this approach derive from the "principle of subsidiarity," which delegates no decision-making function or action to a higher level that can be successfully completed at a lower level. This places the burden of professional integrity squarely on the shoulders of those required to generate the product, and takes maximum advantage of local expertise most familiar with the problem at hand. Administrative overhead is reduced because the technical requirements of decision-making authorities reduce to a comparison of already defined acceptance criteria (agreed to beforehand) with the demonstrated results of V&V. Users are enfranchised in the process and decision makers are assured that those most familiar with the problem are responsible for the results.

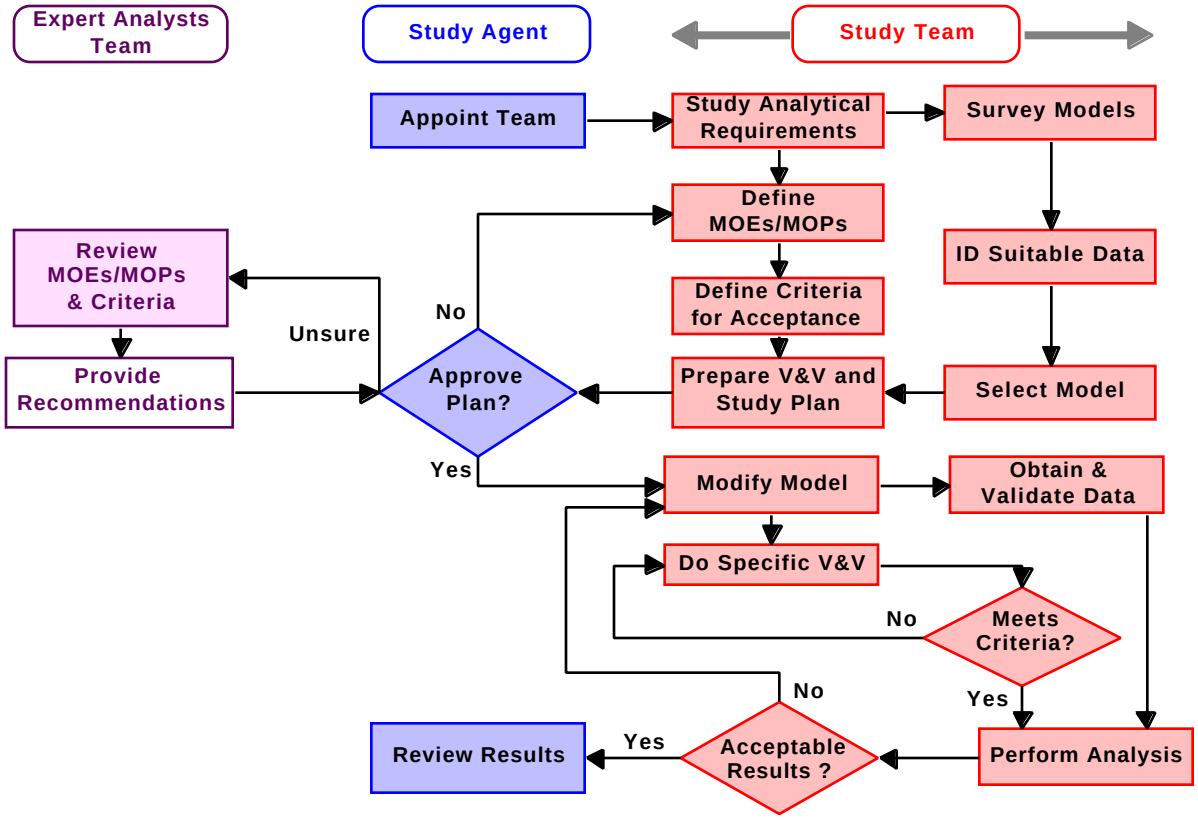

FIGURE 11 ANALYTICAL PROCESS WITH V&V PLAN APPROVAL

To aid the effectiveness of this process, study analysts should be experienced in defining MOEs or MOPs for analytical studies, familiar with a wide range of applicable M/S, and able to develop appropriate acceptance criteria from this information. The modeling community, led by the Defense Modeling and Simulation Office (DMSO) should develop a common checklist of standard questions and issues for guidance in formulating M/S acceptance criteria in support of studies. These acceptability criteria should address issues such as the required degree of fidelity between the model results and real world data as a function of intended accreditation level, the envelope within which these comparisons are valid, and the total envelope in which the model can be expected to provide realistic results. This envelope should be derived from a combination of V&V results and sensitivity analyses. These two factors should yield the range of input parameters over which the model algorithms remain linear, or at least analytic.

If the study is complex, or if the nature of the study precludes a clear definition of acceptance criteria before the analysis is performed, the process could be modified to allow the study agent a second review of finalized acceptance criteria and model V&V results. This modified process is shown in Figure 12. If needed, the expert analysis team would be available to assist the study agent in determining the technical adequacy of the acceptance criteria and V&V results. The second review, which is essentially an accreditation review, would lead to model accreditation or to additional model modification and/or V&V. If the model or the MOEs/MOPs are changed due to the V&V or the accreditation reviews, the analysis, proceeding in

parallel with the V&V, would be checked to ensure that the changes did not affect analytical results to date.

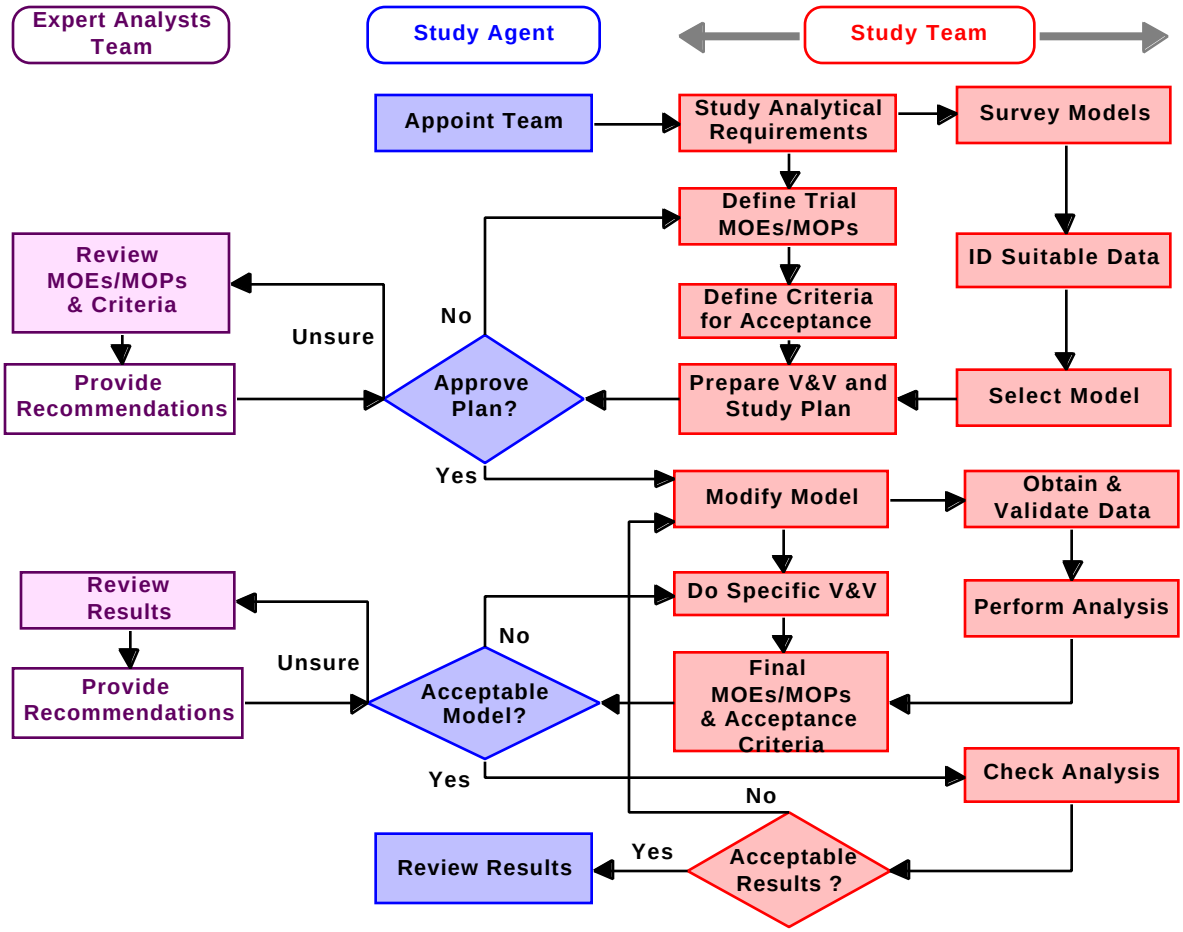

FIGURE 12 ALTERNATE ANALYTICAL PROCESS WITH ACCREDITATION

The proposed process is predicated on the assumption that acceptance criteria are the single most important factor in determining M/S suitability for a particular application, and that with these criteria, any knowledgeable person or group can reach essentially the same decision regarding M/S suitability. This also assumes that the analysts who perform the studies are intellectually honest. If they cannot be trusted, then an independent review of the supporting material and its comparison with the criteria might be necessary. This may be the case where the accreditation proponent has a vested interest in the results of an accreditation decision. Under these circumstances the modified process would be most applicable.

In these notional processes the team of expert analysts acts as an independent "quality assurance" agent. This team would only be required to assist in certain circumstances or when the study agent desires their technical help. Therefore, excessive resources are not spent in mandated accreditation information reviews for simple, straightforward studies. Besides providing review functions when requested, the expert teams could also benefit the study analysts by developing guidelines and suggested checklists for developing both MOEs/MOPs and model acceptance

criteria. Such guides would facilitate analyst training in these critical areas and could be used as a checklist for study agents in conducting their own reviews on future studies.

In the notional processes, the study team is primarily responsible for collecting V&V information, performing additional V&V as necessary, and comparing the results to the acceptance criteria. In the absence of any guidance from the study agent, the study team leader would determine the depth of information needed to support a conclusion that the model meets each of the acceptance criteria. It turns out that SMART products provide a primary source of most of this information, as discussed in Volume II of this report entitled "Information Requirements in Support of Accreditation."

8. INTEGRATION WITH SMART V&V PROCESS

The SMART Project is developing a V&V process that decomposes a model into basic functional elements and collects data from on-going tests that can be used to validate common functional elements in several different models. In parallel, each functional element is verified by an independent agent. The process includes a sensitivity analysis, to determine the most critical functional elements, and correlation of the various functional element validation results with an overall model assessment.

The SMART process has been divided into a series of incremental steps to facilitate application to a newly selected model in a fiscally reasonable manner. This incremental application philosophy is described in greater detail in the companion report, Volume II entitled "Information Requirements in Support of Accreditation." A diagram showing the incremental steps is shown in Figure 13.

The incremental application of the SMART V&V process to a given model will generate the normal SMART products in a sequential series that closely matches the information requirements at the different phases and for different levels of the Navy accreditation process. Table 4 shows the series of sequential products and how they can be grouped into accreditation levels and phases that are similar to those under discussion in the Navy and Air Force. As part of the continuing SMART Project, cost estimating parameters for each incremental step are being developed.

The incremental accreditation approach, if adopted by all users of a model, will permit the early users to develop the basic information to satisfy low risk applications and to lay the foundation for more in depth V&V by subsequent users. Obviously, if a new model is used initially for a high risk study and in depth V&V is required, the initial user will be faced with undertaking the entire effort. Even in this case, however, adoption of the SMART process will allow the user to access and use existing test data that has been collected and catalogued for validation of specific functional elements.

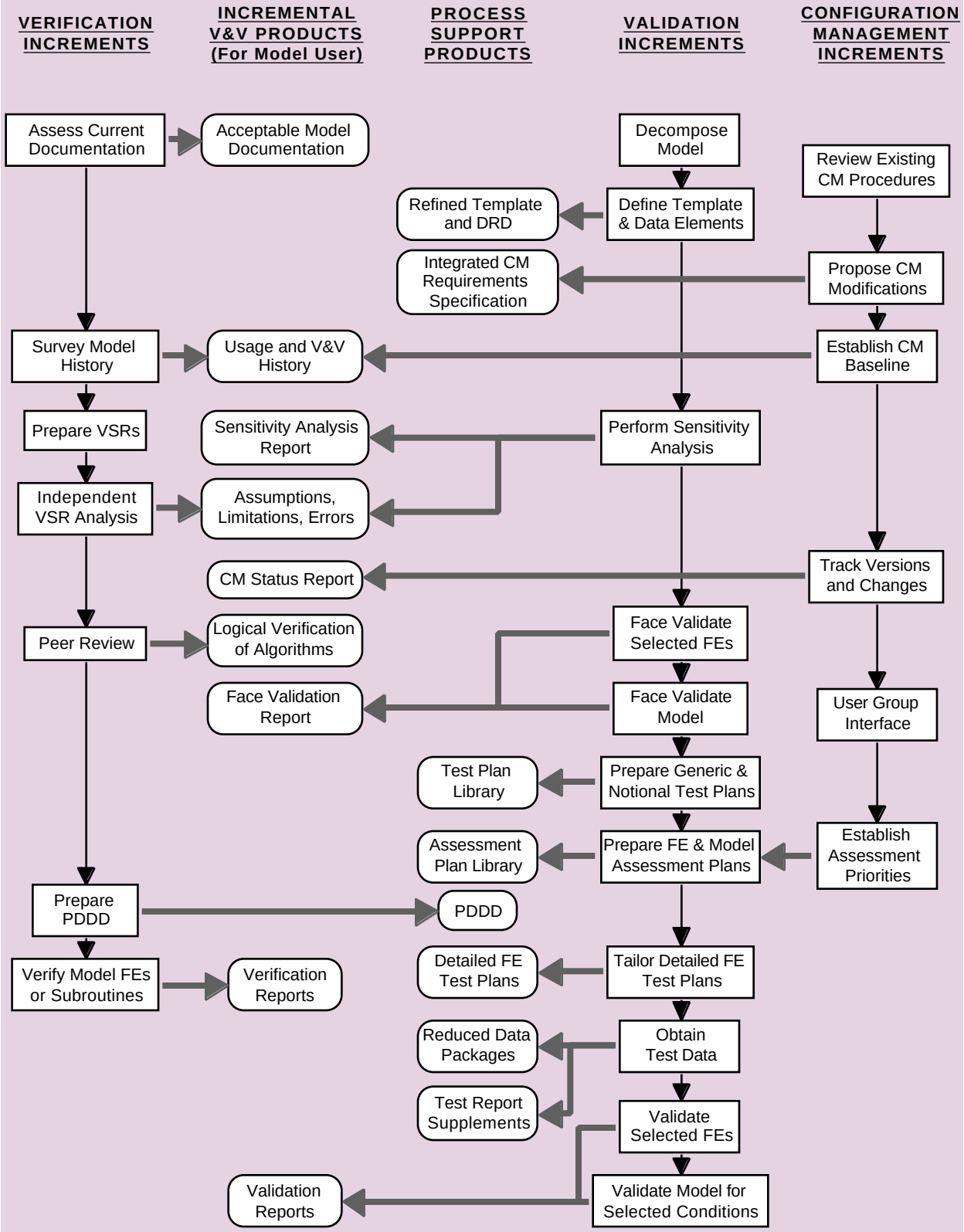

FIGURE 13 INCREMENTAL SMART PROCESS

TABLE 4 SMART PRODUCT RELATIONSHIP TO ACCREDITATION LEVELS

INCREMENTAL V&V PRODUCT	PROCESS SUPPORT PRODUCT	ACCREDITATION LEVEL	ACCREDITATION PROCESS PHASE
Acceptable Model Documentation		Level 1	Phase 1
Usage & V&V History Report			
	Refined Template		
	C/M Requirements Report	Level 2	Phase 2
Sensitivity Analysis Report			
List of Assumptions & Limitations			
C/M Status Report			
Logical Verification of Algorithms			
Face Validation Report			
	Test Plan Library		
	Assessment Plan Library		
	PDDD		
	Detailed FE Test Plans	Levels 3 & 4	
Verification Reports			
	Reduced Test Data		
	Test Report Supplements		
Validation Reports (FEAR & MAR)			

Assuming that a model has been subjected to the SMART process and a set of baseline V&V products exist, an analyst would employ them in selecting a model, planning additional V&V, and assembling the accreditation information. Figure 14 shows how the SMART products would facilitate execution of the applicable study tasks. The advantage of following the SMART V&V process and employing the SMART products during any application specific V&V is that any new V&V results would be added to the V&V library for the benefit of future model users. In this way, each user would have the benefit of in-depth V&V results with a minimal expenditure of individual project resources.

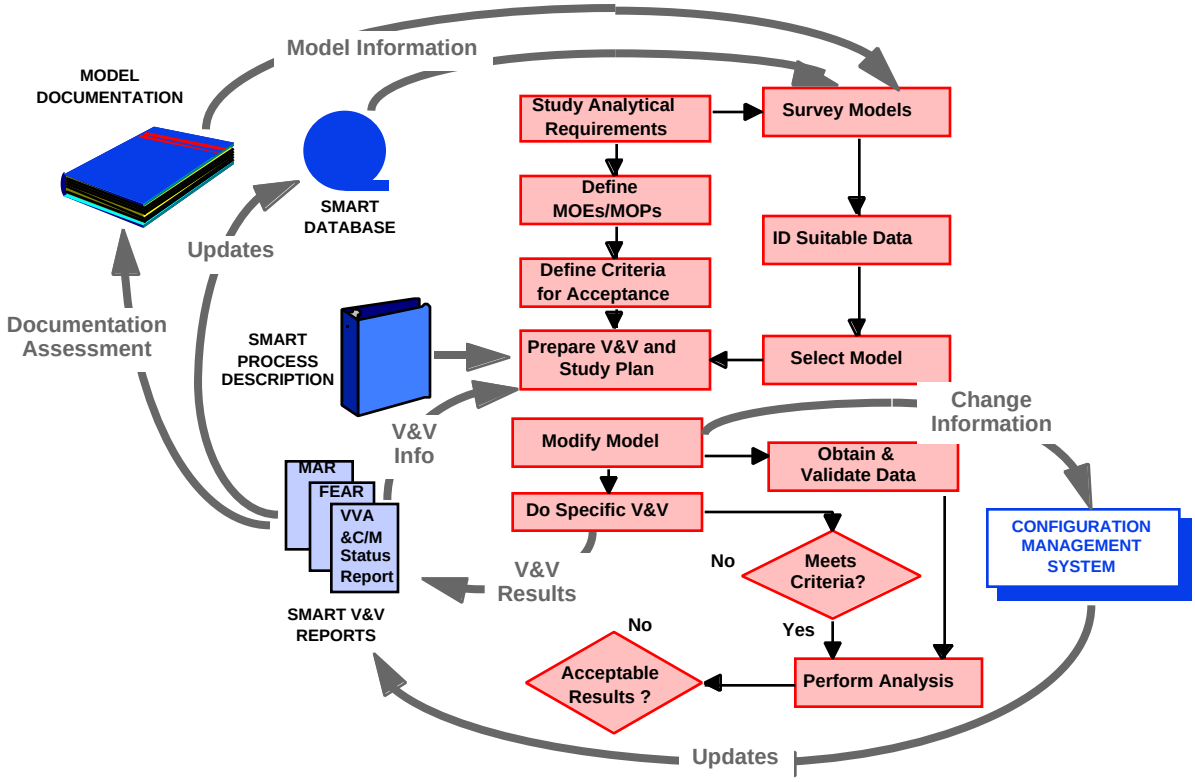

FIGURE 14 SMART PRODUCT USAGE

9. SUMMARY AND RECOMMENDATIONS

In summary, the current accreditation policies rely on extensive bureaucratic reports, reviews, and checks that will most likely waste resources and yet will not necessarily result in more suitable models for each application. The existing practices for model acceptance and use are generally efficient but suffer from a lack of consistency across organizational lines. An approach that capitalizes on the best features of the current practices while meeting the goals of the service policies is needed.

Considering that the most important concerns in current model selection and accreditation practices are proper selection of study MOEs/MOPs and subsequent derivation of model acceptance criteria from these MOEs/MOPs, a suggested accreditation process that incorporates these steps has been synthesized. This process is simple, efficient, and focuses on defining adequate criteria for model accreditation based on appropriately selected MOEs/MOPs. The process is compatible with and, in fact, made more practical if the SMART V&V procedures are used to obtain the V&V information needed to support an accreditation decision.

Based on the foregoing analysis the following recommendations are submitted:

1. DoD and service accreditation policies should focus on development and use of complete and comprehensive MOEs or MOPs and model acceptance criteria to support model accreditation for particular applications. Requirements for obligatory, independent reviews and formal reports should be minimized.

2. DoD and service agencies responsible for M/S policy development should charter one (or a few) team(s) of expert analysts to facilitate development and review of MOEs/MOPs and acceptance criteria when requested.

3. DMSO should sponsor development of initial guidelines, tailored to each class of applications, that will guide analysts in defining their own MOEs/MOPs and acceptance criteria for each application, and for tailoring V&V efforts.

4. DMSO should sponsor a demonstration effort in which the notional accreditation process described in this study is used and independently evaluated.

5. DMSO should seek out opportunities to create automated systems that will assist analysts in defining MOEs/MOPs and acceptance criteria. In essence these would be expert systems that assist in defining V&V requirements tailored to each application.

10. REFERENCE LIST

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3 "Verification and Validation (V&V) and Accreditation of Models"; AMXSY-DA 18 December 1989

4 U.S. Army Training and Doctrine Command (TRADOC) “Models and Simulations (M/S)"; Department of the Army Headquarters, United States Army Training and Doctrine Command

5 Operational Test and Evaluation Command (OPTEC) “Interim Policy Guidance (IPG) 92-2, Verification, Validation, and Accreditation (VV&A) of Modeling and Simulation (M/S) to Support or Supplement Operational Test and Evaluation Command; CSTE-MP (34od); 8 June 1992

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9 "Model VV&A Checklist"; Combat Support Division, AMSAA

10 "Some Thoughts on an Accreditation Process to Develop/Enhance the Credibility Models/Simulations; U.S. Army Material Systems Analysis Activity Aberdeen Proving Ground, Maryland, AMSAA; Philip H. Beavers; 17 May 1989

11 “Accreditation Report for the AMSAA Low Energy Laser Weapon Simulation (LELAWS)"; Report C-29, Combat Support Division Briefing Slides, U.S. Army Material Systems Analysis Activity Aberdeen Proving Ground, MD 21005-5071; M. A. Vincent, B. W. Bradley, D.C. Muscietta, J.G. Thomas, P.H. Beavers; October 1992

12 "Evaluation of Air Defense Effectiveness (EVADE) Aircraft Survivability of Effectiveness Model, Verification, Validation and Accreditation"; Air Warfare Division Briefing Report, AMSAA; December 1992

13 "Accreditation Policy and Methodology for U.S. Army Applications of Expert Systems"; Strayer College, A paper submitted to Dr. Ghazi Alkhatib for computer information systems (CIS) 520 Artificial Intelligence and Expert Systems Theory and Application; Gregory G. Guernsey; November 1992

14 "Memorandum of Agreement (MOA) Between the U.S. Air Force Air Combat Command and the U.S. Army Space and Strategic Defense Command"; U.S. Army Space and Strategic Defense Command; 18 Feb 1993

10.2 Navy

1 Draft OPNAV Instruction “Verification, Validation, and Accreditation (VV&A) of Navy Models and Simulations"; 7 October 1993

2 Draft supplemental document “Principles for Verification, Validation, and Accreditation of Navy Managed Modeling and Simulation” 1 October 1993

3 "TOMAHAWK Simulation Management Policy"; PEO(CU) Instruction 5232.1; Program Executive Officer, Cruise Missile Project and Unmanned Aerial Vehicles Joint Project; 19 July 1993

4 "TOMAHAWK Simulation Management Plan"; PEO(CU) 5232/3; Program Executive Officer, Cruise Missile Project Unmanned Aerial Vehicles Joint Project; May 1993

5 "Verification, Validation, and Accreditation Technology"; A White Paper by D. K. Pace (JHU/APL); November 1992

6 "The State of Military Modeling, Lessons Learned From Model Reviews"; Center for Naval Analyses; Dennis P. Shea

7 "Review of Proposed Verification, Validation, and Accreditation (VV&A) Policies, Procedures, and Guidelines for Any Models and Simulations (M/S)"; Aircraft Weapons Integration Department (Fighter/Attack); David H. Hale

8 "Team Mike Meeting"; NAVSEA/Crystal City; Notes taken by Ron Ketchen, NAWCWPN CO24304; 2 October 1992

10.3 Air Force

1 "The OFTEC Accreditation Handbook": July 1992

2 "HQ AFOTEC/LG4 Guidelines for Modeling and Simulation (M/S) Application, Development, and Documentation"; Air Force Operational Test and Evaluation Center; Burton E. McKenzie, Jr., LTCOL, USAF, Chief, Logistics Studies an Analysis Division; January 1991

3 "AFOTEC Modeling and Simulation Accreditation Process"; Draft POC:OAN; 5 February 1992

4 "Outline of MOSAIC VV&A Interim Final Report Draft"

5 "Verification, Validation, and Accreditation of MOSAIC Status Briefing"; Arvin Calspan Corporation Advanced Technology Center; 18 May 1993

6 "High-Resolution Conflict Simulation Conference"; Lawrence, Livermore National Laboratory; Proceedings; 3-5 November 1992

7 HQUSAF Message 222000Z October 93, Subject: “Modeling and Simulation (M&S) Verification, Validation and Accreditation (VV&A); Interim Policy Guidance

10.4 Other

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7 "Is It You or Your Model Talking? A Framework for Model Validation"; RAND, Project Air Force Arroyo Center National Defense Research Institute; James S. Hodge, James A. Dewar; 1992

8 "Generalizing Concepts and Methods of Verification, Validation, and Accreditation (VV&A) for Military Simulations"; RAND, National Defense Research Institute; Paul K. Davis; 1992

APPENDIX A

INTERVIEW LIST

ACTIVITIES & PEOPLE INTERVIEWED

AGENCY	NAME	INTERVIEW PAGE #
ARMY		
AMSAA (Army Materiel Systems Analysis Activity)	Wyoming (Duke) Paris Jeff Gavlinski MAJ Mike Barton Phil Beavers	1
OPTEC (Operational Test and Evaluation Command)	Greg Gurnsey Margaret Wolchiak	4
ATCOM (Aviation and Troop Command, formerly AVSCOM)	Dr. Tony Kassos	6
DCSOPS (Deputy Chief of Staff for Operations)	CAPT Simpson	7
NAVY		
CNA (Center for Naval Analyses)	Dr. Dennis Shea	8
NAVAIR (Naval Air Systems Command)	CAPT Morris	10
OPTEVFOR (Operational Test and Evaluation Force)	Jim Duff (TD) & CDR Barry Kelly	12
SPAWAR (Space and Naval Warfare Systems Command)	James Weatherly Gary Keck	15
JHU/APL 13N422 (Johns Hopkins University, Applied Physics Lab)	Dr. Dale Pace Simone Youngblood	16
PMA-281 (Cruise Missile Program Manager)	Gabriella Russell	17
AIR FORCE		
AFSAA (Air Force Studies and Analysis Activity)	Clayton J. Thomas David E. Anderson LTCOL Henry Pugh	19
AFOTEC (Air Force Operational Test and Evaluation Center)	Dr. Marion Williams LTCOL Walt Koozin	21 22
AWC (Air Warfare Center)	Don Giadrosich	24
AFDTC (Air Force Development Test Center)	Richard Woodard LTCOL Randy Enright Brad Atherton Dr. Choltia Posey Robert Jones	25
ASC (Aeronautical Systems Command)	Gerald Bennett Mike Weisenbach Dr. Jerry Arnett Jordan Wescott Christopher Pfledderer Douglas McCown	26 28 30
WL (MOSAIC) (Wright Laboratories - MOSAIC Project Manager)	Mike Murray	31
USAF/XOM (Headquarters U.S. Air Force)	Jim Vernon Dr. Al Murashige	32

OTHER		
SURVIAC (Survivability & Vulnerability Information Analysis Center)	Kevin Crosthwaite Dennis Detamore	33
J-MASS (Joint Modeling and Simulation System Project Manager)	Don Martinovich Dan Sammons	34
DMSO (Defense Modeling and Simulation Office)	John Freeman	35
OSD PA&E (Office of the Secretary of Defense, Program Analysis and Evaluation)	Dr. Pat Sanders	Briefed at SSG & DMSO mtgs

APPENDIX B

INTERVIEW GUIDE

ACCREDITATION REQUIREMENTS STUDY
INTERVIEW GUIDE

1 For what purpose(s) does your agency use M&S?

2 What is your accreditation process?

3 Does it conform to any of the process models we have already diagrammed? Which one?

4 Who has authority to accredit models for your use?

5 Is that authority defined in any instruction or charter?

6 If so, what is that document?

7 Is that instruction/charter agency-specific or service-wide?

8 Can we have a copy?

9 On what basis are accreditation decisions made?

10 Considering the various VV&A elements, (e.g. Data source verification, logical verification, code verification, comparison with test results, comparison with other model results, etc.) which ones are required for your accreditation? Which ones are desirable?

11 Is validation of any sort required prior to accreditation?

12 Considering the validation elements already listed, which ones are done? Are there any others?

13 Which elements would you consider most beneficial?

14 Must the validation have been done on the version of the model being accredited?

15 Are special tests run to validate a model, or are previous test data acceptable?

16 For the last few models accredited, what was the cost of any special testing or data collection which was done?

17 Have any models been accredited solely on the basis of past usage, or on the basis of “face validation”?

18 What agencies do you interface with to obtain information on VV&A history of the model you intend to accredit?

19 Is any verification required prior to accreditation?

20 Considering the verification elements already listed, which ones are done to support an accreditation decision?

21 Are there any others?

22 Is configuration management of a model required prior to accreditation?

23 To what extent?

24 Is configuration management handled in-house, or does your agency rely on configuration management activities from other agencies?

25 Describe any configuration management requirements imposed on the accreditation process, and any procedures used to fulfill them.

26 How are any validation, verification, or accreditation activities documented?

27 Are these activities and results published in any form by which other model users can become informed of the results and use them?

28 What are these forms, and can we have access to some typical accreditation reports?

29 What types of model information is needed to determine whether the model fulfills the analytical requirement? What model summary data would you want in a database?

30 Do you have any examples of criteria which you used as a basis for making an accreditation decision or in determining that a model was acceptable for a particular use?

31 In looking at the matrix of accreditation requirements, which ones are either required, desired, or considered acceptable to accredit a model.

32 Who else in this agency can we talk to concerning accreditation efforts?

33 Who else in your service should we be talking to about accreditation requirements?

AIR FORCE SPECIFIC QUESTIONS

For AFOTEC

34 Two guides exist for AFOTEC M&S accreditation; POC:OAN Draft of 5 Feb. 92 and the LG4 guide of Jan. 91. Which one(s) express AFOTEC policy? Who is Accrediting authority, M/S Committee or as appointed in Accreditation Plan?

35 LG4 guide says analysts are responsible for Configuration Control for M&S they develop. Does AFOTEC do any CM for existing models?

36 When using existing models, does AFOTEC require that the four documents (Management manual, Analysts Manual, Programmers Manual, & Users Manual) be available?

37 For existing models if manuals do not meet your standards, are they rewritten?

38 Should the DOT&E issues (identified on the separate issues sheet) be addressed or investigated as part of the SMART process?

NAVY SPECIFIC QUESTIONS

39 What relationship exists between the Navy VV&A plan drafted under SPAWAR sponsorship and the JACG initiative to develop a unified VV&A process for survivability models?

40 Of the SMART model set, only ESAMS is listed in the M&S catalogue being prepared by SPAWAR. Should the others be included?

41 Goal #10 for Team MIKE is to "establish a methodology/procedure for providing documentation, certification, and configuration management for Naval Warfare models." Do the SMART documentation, assessment reports, and CM plans meet this requirement?

42 Goal #7 is to "establish and catalog common data bases IAW the principles supporting Navy evolution toward common data bases through the NWTDB process, set forth in OPNAVINST 9410.5." Need more information about that instruction and related Navy policies on data base development.

ARMY SPECIFIC QUESTIONS

43 Is there an Organization Chart which shows the various Army organizations, committees, and activities which get involved in accreditation?

44 Any contacts in Army Model and Simulation Management Office (AMSMO), Office Deputy Chief of Staff for Operations (ODCSOPS), or MISMA who should be interviewed?

45 **For MISMA** What progress has there been on the MISMA master plan (referenced in the Jim Metzger brief) for credibility assessment? Is that AR 5-11?

46 **For AMSMO** What progress on the AMSMO "How to" handbook? Who is preparing it? Can we contact them for information gathering purposes? Who is Point of Contact (POC)?

47 Are accreditation procedures listed on pg. 6 of SAUS-OR memo dated 30 Oct 89 still complete & valid? What does the statement "*Review of how input data and scenario data are used or modified internal to the model."* mean?

48 Can I get a sample of a "good" V&V plan and V&V report?

49 **For OPTEC** Is the V&V documentation format (encl. 6 of OPTEC IPG 92-2) still valid? What is an "uncertainty analysis"?

50 Are any SMART models included in the list of Army "Touchstone" M&S? What aircraft survivability models are included?

51 AR 5-11 has provisions for accreditation of a model for a "Class of Applications". Define/describe a "class of applications".

52 Should SMART attempt to produce a V&V report supporting accreditation for a Class of Applications? If so what class(es) should be covered?

53 Should the SMART produced test data conform to AR 25-9 and the Army Data Encyclopedia? If so, what are the requirements and costs? Would Army provide funds to support tailoring data to these requirements? Who should funding requests of this nature be directed to?

54 What are some typical acceptability criteria which are used in evaluating a model for a class of applications?

55 Where can I get a copy of AR 25-1 and AR 25-9?

APPENDIX C

INTERVIEW SUMMARIES
ARS INTERVIEW REPORT

INTERVIEWEES: Mr. Wyoming (Duke) Paris DATE: 1 April 1993
Mr. Jeff Gavlinski
MAJ Mike Barton
Mr. Phil Beavers

ORGANIZATION: U.S. Army Materiel Systems Analysis Activity (AMSAA)

ORGANIZATIONAL RESPONSIBILITY: Performs analysis and evaluation on major Army systems. Acts as an independent evaluator for DT and some OT. Uses M&S performing analyses.

INTERVIEW SUMMARY: The interview began with a short presentation on the background and purpose of the SMART Accreditation Requirements study. During the course of the presentation, several recommendations were made concerning the SMART Project deliverables:

- The CASE tools used to analyze the SMART model set were questioned. AMSAA had tried to use CASE tools to analyze some of their models and found that they could not compile the tools with their large FORTRAN models.

- The configuration management (CM) process to be developed by the SMART project could be a concern. In today's resource constrained environment, a CM process which involves extensive documentation and multiple meetings would be too costly. For models whose configurations are controlled by AMSAA, one person controls changes and approves distribution of code to potential users. That person exercises judgment as to what code is sent to a user. In most cases only executable code is sent.

- A suggestion was made that the model history to be recorded in the SMART data base also contain information on any comparisons made between models.

- It would be beneficial for SMART to keep track of time and cost estimates for performing V&V. The AMSAA personnel expressed concern that the SMART process for doing V&V might be higher than they (or anyone else) can afford. They presently spend anywhere from 6 months to 2 years on a V&V effort, depending on the size and extent of application of the model. During that time they have anywhere from 1 to 3 people working on the effort. They felt that the SMART efforts will not negate the need for AMSAA personnel to perform their own V&V on a model but it would reduce the scope of the effort required on their part.

- In discussing SMART contributions to accreditation, a key factor from AMSAA's point of view was the value added to the accreditation process relative to the cost of production of accreditation support deliverables. This was a theme that recurred frequently during the discussions.

- A possible SMART product suggested by Phil Beavers was a knowledge based or "expert system" piece of software that would ask questions of the user and suggest a V&V outline or plan depending upon the level of accreditation required, the resources available, the technical requirements of the accreditation (which would vary by both service and application). It could be based on AMSAA's V&V checklist as a starting point. Mr. Beavers said that such an application would provide a typical user an "80% solution" to typical accreditation problems, leaving the remainder to be tailored to the user's specific situation.

Officially, AMSAA accredits models only for their own use. Unofficially they are responsible for accrediting models for which they have CM responsibility. They also are involved in accrediting models for joint use and for use in COEAs where the model usage crosses organizational lines.

AMSAA has recently accredited two models for their use in particular applications. These models are EVADE and LELAWS. The LELAWS accreditation was a 20 month study involving 1-3 people. It did not involve any separate test data collection effort. All the data used in the V&V was obtained by piggybacking on other tests.

In terms of the draft Navy VV&A policy AMSAA typically provides a "level 3" accreditation. The LELAWS accreditation package would probably meet "level 4" accreditation requirements. No model has been approved for "domain accreditation" at AMSAA. A copy of a typical accreditation package, which consisted of hard copies of the view

graphs used in presenting the supporting information to the director of AMSAA, was provided. In order to conserve effort and paper, annotated copies of the briefing slides are used to document the V&V effort vice a formal V&V report. An accreditation request briefing may take about a half day and be presented to the director and various key AMSAA personnel.

AMSAA has both a checklist and a questionnaire which are used as guidance in preparing an accreditation request briefing. Copies of each of these were furnished.

AMSAA accreditation efforts to date have been for total models. They have not performed V&V on model changes in order to accredit an updated version of a model which was previously accredited. If they were to accredit an updated model, they would probably perform a sensitivity analysis on the changes and updates to the model, and then do a V&V on the changed portions only. If some other activity had accredited a previous version of a model which they intended to use, they would look at the V&V history and use that as a basis for developing an accreditation plan for the updated model.

AMSAA is being directed to provide accreditation support for 7 government and 10 contractor models in support of the RAH-66 Commanche COEA, although the time frame for completion depends on budget uncertainties. SMART will send Duke Paris its most recent reports on ESAMS and RADGUNS both for technical review and possible later use in the COEA effort.

In preparing an accreditation plan, the user's and analyst's manuals are important. They don't feel that typical software life cycle documentation is necessary to support accreditation. Any documentation of methodology studies is important. (Methodology studies documents are descriptions of the physics, equations, and possibly the implementation of a part of a model such as the P_K model for a particular gun. A typical model part may be common to several models and described in a methodology study.)

AMSAA considers "benchmarking" (the comparison of one model's results with those of another model) another useful aspect of the accreditation process. It is especially useful if one of the models has already been accredited.

One tool that AMSAA uses in verifying a model is the McCabe Complexity Rating. It identifies the most significant modules in a software program by reading, segregating, counting, and listing the number of logical decisions by subroutine. This tool is based on the theory, demonstrated in several programs, that the number of errors in a subroutine is directly related to the number of decisions which are made in the subroutine. SMART can use such a tool to help in the prioritization of functional elements for V&V efforts on its models. Mr. Paris agreed that he could help us get this tool.

The following personnel were suggested as those who might be able to provide additional information on accreditation requirements:

Roy Willoughby, Louis Dominguez	TRAC/WSMR	CASTFOREM CM
Annette Ratzenburger	MSMA	
Walt Hollis	DUSA(OR)	set up MSMA
COL Knox		

ARS INTERVIEW REPORT

INTERVIEWEES: Mr. Greg Gurnsey
Ms. Margaret Wolchak

DATE: 30 March 1993

ORGANIZATION: U.S. Army Operational Test and Evaluation Command (OPTEC)

ORGANIZATIONAL RESPONSIBILITY: Performs operational tests on Army systems. Uses M&S to plan tests and extrapolate test results, and to overcome limitations and constraints on OT.

INTERVIEW SUMMARY: The interview began with a short presentation on the background and purpose of the SMART Accreditation Requirements study. During the course of the presentation, several issues were raised which might impact the project. These issues are:

- The specific CASE tools used to analyze the SMART model set were questioned. OEC questioned if the CASE tools analysis was thorough, using a complete set of tools. Different CASE tools have different purposes.

- The Data Requirements Dictionary should list additional factors besides measurement accuracy. Two factors which are important are precision and variance.

- The VV&A history of a model must include identification of the version of the model that was accredited.

- The term "Unified CM Process" should be revised to "Consistent CM Process". This will avoid confusion since "Unified" has a different connotation meaning multi-service within DOD.

- The commonalty matrix which identifies common functional elements in different versions of a model is now based on the similarities between the functional elements. It should also consider the interfaces between the various Functional Elements (FEs) since commonalty can be affected by the interfaces between FEs.

V&V is really a process to collect evidence to support a decision (accreditation) that a model is suitable for a particular application . The definition of acceptability criteria is critical to making a valid decision. These criteria vary with every application. OEC has published a closed set of techniques for generating acceptability criteria. These are contained in the OEC IPG 92-2. When planning a V&V effort the cost of collecting data, as well as other suitability information, is important. OEC would benefit if the SMART Project could provide information on the cost of collecting different types of data. With regard to costs, Mr. Guernsey suggested that tracking the cost of the various components of accreditation would also be value as an aid to planning V&V efforts within a resource constrained environment.

Within OEC accreditation is always driven by the application. The MOEs and MOPs for an accreditation are based on the data elements or the conditions of the application. A copy of an accreditation report was provided to the SMART Project personnel to serve as a model and provide information on OEC's approach to accreditation.

Mr. Gurnsey offered the following observations on VV&A processes in general:

- Validated tactical environmental data is very important for any analysis.

- Military judgment is very important in doing face validation. This critical part of V&V is missing in the SMART Project.

- Any lessons learned about data recording or model validation could be sent to the ranges to assist them in structuring future tests.

- The Army MSMA has established an Army Data Dictionary related to M&S. SMART personnel should coordinate with them to help develop common terminology across project and DOD lines.

- DIS (Distributed Interactive Simulation) is chartering a VV&A working group, chaired by Dr. Pace, that will have a formal meeting in summer or fall. There will be a call for papers shortly. This is an opportunity for presenting the SMART concept to a wide audience. The group is looking to define a VV&A process and will be looking for validated data. This is a possible overlap area with the SMART Project.

Several additional points of contact were identified. They are:

Mike Bauman	TRADOC Analysis Command Ft. Leavenworth	(913) 684-4689
CW4 Weidel	TEXCOM, Ft Hood (Commanche simulators, LFT of Hellfire missiles coming up)	(817) 288-9992
Lana McGlynn	MSMA (also Annette Ratzenburger)	(703) 607-3385
Don Blanton	AMSAA (Assist transition planning, Army Data Dictionary)	(410) 278-3368
Irwin Atzinger	AMSAA	(410) 278-6576

ARS INTERVIEW REPORT

INTERVIEWEE: Dr. Anthony G. Kassos DATE: 3 February 1993

ORGANIZATION: U.S. Army Aviation and Troop Command (ATCOM)

ORGANIZATIONAL RESPONSIBILITY: Dr. Kassos is involved in system assessments using models and simulations. He will assist program managers in accrediting models for this analysis.

INTERVIEW SUMMARY: Dr. Kassos provided a copy of the new Army Regulation (AR) 5-11. He has not yet done an accreditation under these new guidelines. He is planning to start an accreditation soon. He will be using the SMART approach in this accreditation. If any process problems arise he will resolve them as he sees best.

AR 5-11 applies throughout the Army. Any previous guidelines by individual commands have either been superseded or rewritten to conform to AR 5-11. Throughout the army, no models have as yet been accredited for a "class of applications" as provided for in this regulation.

In response to a question about any other products which should be provided by SMART, Dr. Kassos indicated that the results of a "Face Validation" should be included in the model validation reports. He felt that such a face validation is actually done as part of the SMART assessment process.

Within ATCOM they have not validated any models with test data. Several attempts have been made but none were very successful. In general, testing has been done to support model development.

AR 5-11 makes the model proponent responsible for configuration management. The following persons have that responsibility for the models shown:

RADGUNS	Dwight Fitzsimmons	FSTC
HELIPAC	Jeff Gavlinski	AMSAA

Another point of contact for possible additional information on accreditation is Dan Willard who is a member of the SMART Steering Group.

Dr. Kassos provided information on the Army organizations which use M&S. An organization diagram is attached.

ARS INTERVIEW REPORT

INTERVIEWEES: CAPT Simpson DATE: 24 May 1993

ORGANIZATION: Office of the Technical Advisor, Deputy Chief of Staff for Operations, U.S. Army

ORGANIZATIONAL RESPONSIBILITY: The office of the Technical Advisor conducts studies and performs analyses to support headquarters decisions. They are the accreditation proponents for COEAs.

INTERVIEW SUMMARY: The analysts in this office prepare accreditation information to support accreditation of models used in COEAs. They have not yet accredited any models. They are presently involved in accrediting one model. One of the difficulties is that they use Force Level models in COEAs rather than engineering level models. Force level models are very difficult to validate and accredit since there are a number of human decisions incorporated in force level models. Such decisions are hard to validate.

When performing an analysis, they try to employ the "semi-formal process". However, if time constraints dictate, they may switch and use the "informal process". If they intend to use an existing model, they try to use the alternate process which gives the study authority the opportunity to approve or reject the selection of the model. If the model requires some modification, the V&V tends to be done in parallel with the analysis and the accreditation is almost in parallel with the analytical results.

They are interested in Configuration Management. They want to know that the model they use is what they actually intended to use.

TRADOC at WSMR will probably do a COEA on the Unmanned Air Vehicle (UAV) using CASTFORM

CAPT Simpson provided me with an outline for a generic accreditation support data package. This outline was taken from an in house paper and is being used to guide the current accreditation.

ARS INTERVIEW REPORT

INTERVIEWEE: Dr. Dennis Shea DATE: 30 March 1993

ORGANIZATION: Center for Naval Analyses (CNA)

ORGANIZATIONAL RESPONSIBILITY: Performs studies and analysis, primarily for OPNAV.

INTERVIEW SUMMARY: When CNA performs an analysis using a legacy model they first review the model to understand the approach, algorithms, and assumptions embedded in the model. Using this information, they decide if the model is appropriate for the intended application. Although they have not been requested to perform any code verification as part of their model reviews for other Navy activities, they do perform a "logical verification" on such a model. Logical verification includes the following steps:

- evaluate the correctness of the algorithms
- identify assumptions needed to use the model
- identify variables included/excluded in the model
- confirm consistency of units and coordinate systems throughout the model
- explore implications of time-step sizes.

As part of a model review, they do perform sensitivity analyses if the model is complete, documented, and can be ported to a CNA computer. They would also identify the limitations on the range of applicability for the algorithms used in the model. If a more thorough VV&A were necessary and there were insufficient documentation, they would begin with the code and reverse engineer the model to develop the diagrams needed to do a VV&A. They have performed this type of V&V on the CMAS model as well as approximately 30 other models developed for Navy use. Release of the VV&A for report for CMAS must be approved by N81.

The present approach relies extensively on the competence of the CNA analysts. Dr. Shea feels that the present approach is sufficient. If a more formal VV&A procedure is required, he feels that it must be relatively cheap when compared to model development costs. The present review takes anywhere from 6 months to 1+ years for a given model. Since the Navy has, perhaps hundreds of existing models, a formal review of each which employs the existing approach would be unaffordable. To be helpful to a sponsor, a formal VV&A approach should result in:

- sufficient evidence to accredit a model or,
- recommendations to correct or work around noted deficiencies or,
- an alternative approach to the pending analytical issue (for which the model has been proposed as an analytical tool) that does not require the model under review. This might be an alternative model or an analytical approach that does not require a computer model.

The final report should also describe the class of problems for which the model can be used.

Dr. Shea commented that an approach to a detailed VV&A which required anywhere from 1/2 to 1+ years time and resources for each of the Navy's existing models would probably be unaffordable. Navy sponsors usually can't afford the time it would take to

carry out a detailed VV&A, and might view such a formal VV&A requirement as a bureaucratic burden. Dr. Shea feels that there is no opposition in the Navy to having a detailed VV&A procedure; the opposition would arise when study sponsors were forced to pay for VV&A. Dr. Shea commented that study sponsors don't want to hold up a study just to complete formal VV&A requirements. From Dr. Shea's point of view, the Navy doesn't think VV&A is affordable for existing models and simulations, implying that some sort of "grandfather" accreditation for these models might be appropriate.

The Navy currently has no requirement specifying the level of V&V required to accredit models for various applications. However, when N81 funds CNA analysis, it expects the models used to be reviewed using the support funds.

As a side issue, it was reported that Dale Pace, who is drafting the Navy VV&A policy, believes that CASE tools can significantly reduce the time required to perform VV&A on models under development by automating software documentation. Since poor documentation has been the greatest obstacle to performing VV&A, any techniques to automate this process would be a step in the right direction.

Dr. Shea noted that the present process for releasing and publishing model changes is painfully slow. Documentation of the changes significantly lags the changes to the software. Any C/M system developed by the SMART project should speed up the process for releasing and publishing model changes.

ARS INTERVIEW REPORT

INTERVIEWEE: CAPT Raymond Morris DATE: 2 April 1993

ORGANIZATION: Naval Air Systems Command, Warfare Analysis Division (AIR-526)

ORGANIZATIONAL RESPONSIBILITY: Performs analysis on proposed weapons and systems. Uses models and simulations for analyses which impact COEAs and which are inputs for advanced planning.

INTERVIEW SUMMARY: In planning a study, AIR-526 usually assigns a team consisting of a military officer, a senior analyst, and a junior analyst. They prepare a study proposal which outlines how the analysis will be performed, alternative approaches which may be tried, and candidate models for the analysis. The models typically used are ones which have been designed and used to give good first order insights and solutions to military problems. Results of these models have held up well under empirical scrutiny in past studies.

When completed, the study plan is reviewed and presented to the study chartering authority for approval. Having received and approval, AIR-526 considers the models which were cited in the plan as being acceptable for use in the study. This does not preclude additional models from being employed as the study progresses.

In performing the analysis, models are used to predict results at the 1-v-1 and M-v-N levels. Comparative runs are made with different models and the results are scrutinized for realism and consistency. Analysts often combine the results of several simple models into a larger context through a variety of methods including "spreadsheet" models or Monte Carlo type simulations to analyze battle force and campaign level outcomes. The underlying principle of these studies is to analyze and explain why a certain result occurred and what parameters drove those results. AIR-526 usually avoids using campaign level models, since the results are difficult to break down into individual engagements to determine the effects of changes in the scenario.

Since several variations in system design as well as the scenario might be analyzed, the models are typically refined several times during an analysis in order to investigate the effects of these variations. Therefore the models must be robust, simple to use, and economical to run. This factor mitigates against a formal VV&A process for each variant of each model used in the analysis.

Because the studies are typically of a short duration, there is neither time nor money available to conduct a formal V&V of each model and each variant. The study director is primarily responsible for ensuring that the appropriate model(s) are used, any changes to the models are logically correct, and that these changes are coded correctly. Within AIR-526 the principle means of building confidence in the analytical results obtained through the use of models is through the use of multiple models and by conducting informal peer reviews. Since multiple models are employed in a problem, analytical results from each model are compared with each other. The results are also checked against the experience of senior analysts and active duty military fleet operators who are part of the analysis team. (In essence a face validation is performed.) During the

course of a study, informal reviews by other senior analysts are conducted to help identify any logical gaps or errors in the analysis or model results. (These reviews are similar to "Peer reviews" used by other organizations in performing model V&V.) At each major briefing of the study results to sponsors and/or analysts, an implicit “go-ahead” is obtained if the results square with experience and correlate with similar uses of the models in other parallel studies. Through this comparative analysis and review process, AIR-526 builds confidence in the study results. The present process is relatively inexpensive and well suited to operations analysis problems.

Since operations analysis is most useful in exploring new systems concepts, existing models do not generally cover the full parametric range. Therefore, operations analysis models tend to evolve in a dynamic fashion. The lifetime of a particular model configuration is often one study. If a highly formal VV&A process were forced upon AIR-526, these COEA studies would be greatly stretched out and the study costs would rise significantly. VV&A is more appropriate for models which are used repetitively (e.g. training models, simulators, etc.) The COEA process should not be burdened with a requirement for a formal VV&A of each model. Flexibility in the early phases of analysis is essential to producing timely results. A strict VV&A policy for M&S would tie the hands of analysis agencies too tightly to be effective.

ARS INTERVIEW REPORT

INTERVIEWEES: Mr. James Duff (Technical Director) DATE: 29 March 1993
CDR Barry Kelly

ORGANIZATION: Operational Test and Evaluation Force (OPTEVFOR)

ORGANIZATIONAL RESPONSIBILITY: Responsible for performing operational tests, evaluating new systems, and determining their suitability for Navy use.

INTERVIEW SUMMARY: OPTEVFOR established an analysis group only two years ago. The group has grown from a single M&S "expert" to a division with 12-15 analyst/modelers and one software "expert," distributed among three branches: Simulation and Modeling, Analysis, and Software. CDR Kelly heads the Simulation and Modeling branch. Due to the cost and security issues surrounding testing, simulation and modeling is becoming more widely used in OPEVAL.

Current OPTEVFOR policy guidance on the use of M&S in OT discourages the development of new M&S, but use of existing M&S is acceptable. The OPTEVFOR focus is on the development and enhancement of expertise in adapting and using models for OT purposes. V&V efforts in support of accreditation decisions are typically contracted out. The advent of J-MASS will require that OPTEVFOR develop the capability to create models using the J-MASS architecture. Therefore, OPTEVFOR must start to work toward developing that capability now. If it doesn't, it will eventually lose the capability to use M&S effectively to support future OT. OPTEVFOR is also looking to get involved with the DIS (Distributed Interactive Simulation) effort.

OPTEVFOR uses models to:

1 Assess the lethality of weapons
2 Extend test results to conditions difficult to test
3 Investigate aspects where tests cannot be performed
4 Refine test planning
5 Refine resource requirements
6 Assist in early operational assessments
7 Avoid testing where safety or environmental risks are too high
8 Assess nuclear effects
9 Evaluate communications networks

In selecting a model for a particular application, OPTEVFOR seeks information from the J-8 catalogue, SURVIAC, the system program office, and other generic sources (e.g. CNA, Naval Post Graduate School [NPGS], Navy labs). The following questions are asked when looking for a model:

10 What operational questions must be answered?
11 Is use of a model(s) appropriate to answer these questions?
12 What is the model expected to provide relative to these questions?
13 What models are available?

14 What is known about the model's intent, assumptions, performance and fidelity? (High previous usage of a given M&S is not essential.)
15 Is the (or are these) model(s) appropriate? (Discuss the model with the developer and past users to determine its appropriateness.)
16 Can the model be modified (or a new model developed) to suit the purpose?
17 Will the system program office support the development or modification of the selected model?
18 Is there an independent group or activity which can V&V the model?
19 What is the V&V history of the model? (This is not an overriding factor.)

OPTEVFOR has not approved the accreditation of a model in the past year, although two models have been subjected to the accreditation process. In both cases the recommendation was for non-accreditation. In the past, OPTEVFOR has accredited the SIMVAL model for the SSN-21. This accreditation was done by CNA. Mr. Duff commented that OPTEVFOR makes use of CNA in this role as often as possible. Also BDM Inc. conducted an accreditation study on the IADS model 2-3 years ago. OPTEVFOR generally has another activity, independent from the model developer, perform the V&V necessary to support an accreditation decision. They feel that CNA has the credibility to do adequate V&V for their accreditation's. OPTEVFOR looks to CNA's V&V activity to state where the model will be adequate and where it fails to adequately represent the conditions of the application for which it is intended to be used. The accreditation process takes anywhere from 6 months to 2-3 years.

Mr. Duff feels that model verification is feasible. Model validation, however, is more difficult and cannot always be done. The time frame for the use of the model can significantly impact the amount of V&V which is possible. Moreover, Mr. Duff feels that we will never have a full validation of any model, but that statements about the boundaries of model applicability are sufficient to support accreditation decisions. CDR Kelly expressed the opinion that VV&A is a "random space" that the services are now trying to put some order into.

If a model is to be used to support an OT decision, either fully or partially, the model must have an independent agent perform V&V in support of accreditation. The model developer can participate, but must not be solely responsible for, this V&V. If the model is to be used in test planning, or in some other activity in support of OT, it need not be accredited. If it will be used to resolve a critical operational issue (COI), it must be accredited.

OPTEVFOR has no immediate need for the type of accreditation support material provided by SMART for the SMART model set. However, SMART's general accreditation support products (V&V Process Guides, Configuration Management Handbook, VV&A Data Base, etc.) would provide a useful "stake in the ground" for V&V and C/M activities in support of accreditation.

In response to a question as to whether survivability models are used by OPTEVFOR, CDR Kelly indicated that the use of survivability models would require the development of a system model to interface with the survivability model. The cost of this development would be a problem. It would probably be less expensive to actually exercise the system at Echo range than to develop the necessary models to interface with existing

survivability models. CDR Kelly indicated that most survivability COIs are resolved by the time the system gets to OT. If survivability is still a COI in OT, the system program manager will probably describe what was done in DT and suggest an approach to be used in OT. OPTEVFOR will either accept or modify that approach to make a judgment regarding the COI. OPTEVFOR typically uses system-specific models rather than generic models to support OT evaluations.

Mr. Duff mentioned his concept of a "Statement of Functionality." If tactical software is modified, a statement of functionality should be developed to identify the functional effect and limitations of that particular modification. If a model is changed and must be reaccredited, a statement of functionality about the model changes would be very useful in guiding the additional V&V which should be done to accredit the changed model.

The following personnel were suggested as possible additional contacts:

Name	Role	Phone
Jim Sikora (BDM, Albuquerque)	Prepared MORS accreditation guide. Will publish a white paper on the accreditation process. Knows attendees (especially service reps) at meeting where templates were discussed.	4104 848-5650
Dee Ritchie (DSMC, Ft. Belvoir)	Knowledgeable on accreditation requirements. Editor of PHALANX (MORS newsletter). Knowledgeable on MORS SIMVAL.	4105 805-2887 or (703) 805-3698
Pat Sanders, PA&E		4106 697-3521
Steve Booher (Teledyne Brown Engineering)	Developed model similar to ESAMS. Can discuss V&V on that model.	4107 276-4603

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. Jim Weatherly
Mr. Gary L. Keck

DATE: 30 March 1993

ORGANIZATION: Space and Naval Warfare Systems Command (SPAWAR 31)

ORGANIZATIONAL RESPONSIBILITY: Tasked by OPNAV (N81) to draft Navy policy for conducting and managing VV&A on models and simulations.

INTERVIEW SUMMARY: SPAWAR is leading the effort to develop a Navy policy for VV&A of M&S. Mr. Weatherly felt that the SMART process, as outlined in the presentation given by Paul Muessig, would form the basis for performing VV&A on legacy models. The draft policy primarily addresses VV&A for newly developed models.

In order to accredit legacy models under the proposed policy, he thought that the OPNAV sponsor would be the accrediting authority and the V&V proponent would submit the information to support an accreditation decision. The amount of V&V would depend on the application, just as with new models. For example, if safety of flight is involved, a greater amount of V&V would be required than if the model were to be used only in test planning.

It was suggested that the SMART approach to VV&A be briefed at the summer meeting of Team Mike, which is the advisory group that guides the development of the Navy's VV&A policy. The briefing should compare our outputs and processes with those outlined in the draft Navy policy document. It should also point out those things which SMART is doing which are not covered in the Navy document. In essence, the SMART approach may serve as a “validation” of the Navy’s proposed VV&A paradigm for the important class of legacy models. The SMART approach may also help the refine the policy on non-Navy models used in support of Navy studies.

One approach for generating this briefing is to write an accreditation plan for a model, turn the process into a flow chart, and compare this flow chart with that in the draft Navy policy document.

Dr. Dale Pace at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) should be contacted so that the briefing can be coordinated with any changes or modifications which might be made to the draft Navy policy. A strawman outline of the issues to be briefed should be provided to Weatherly in about 6 weeks to 2 months.

ARS INTERVIEW REPORT

INTERVIEWEE: Dr. Dale Pace
Ms. Simone Youngblood

DATE: 25 May 1993

ORGANIZATION: Johns Hopkins University, Applied Physics Laboratory

ORGANIZATIONAL RESPONSIBILITY: Primary contractor responsible for developing the Navy policies for M&S VV&A. Drafted the existing Interim Policy Guidance for the Navy.

INTERVIEW SUMMARY: Dr. Pace indicated that the concepts contained in the draft VV&A IPG is based on his work in the field of model VV&A. One major effort was his task to perform an independent validation review of several models for SPAWAR 31. Dr. Pace provided a disk with a bibliography list which he used in preparing the draft Navy IPG.

During the course of this and other meetings on the IPG, Dr. Pace stated that the most important part of the V&V process which is outlined in the IPG is the Concept Validation Phase. The conceptual validation includes a check of assumptions, limitations, and description of the subject being modeled. (These factors have been cited by several other interviewees as being important.) He also expressed the view that M&S are end products in themselves. In that respect they should have a structured VV&A process which each must undergo to ensure that they are as good as possible when released to the user community.

In response to a question about the feasibility of assembling a team of independent experts to conduct each phase of the V&V effort outlined in the IPG, Dr. Pace indicated that the team need not be large. In fact, for some simple models, the team may be only one person to review what the model developer has done. The independent person may even be from the same activity as the model developer in order to overcome the problem of finding available people.

ARS INTERVIEW REPORT

INTERVIEWEE: Ms. Gabriella Russell DATE: 30 March 1993

ORGANIZATION: Tomahawk Cruise Missile Project Office (PMA-281)

ORGANIZATIONAL RESPONSIBILITY: Responsible for using various models to generate data which are used in the Theater Mission Planning System (TMPS). Uses survivability models to generate P_k data for the TMPS.

INTERVIEW SUMMARY: The Tomahawk Program is engaged in a major upgrade to the TMPS. The title for this effort is the Theater Mission Planning Center Upgrade (TMPCU). Testing of this system will be done by OPTEVFOR prior to its certification for operational use.

Initially, STRATCOM provided data which was generated from ROPES to input to the TMPS. During Desert Storm the Navy found that the STRATCOM data didn't fit the TMPS planning needs. Now the project office is using ESAMS, RADGUNS, TRAP, and AASPEM to generate data for the TMPCU. These models were selected at the direction of VAdm Bowes. One of the concerns in selecting these models was that none of them were proprietary. Ms. Russell indicated that accreditation of these models by some outside agency would be very beneficial, but that her group has no plans (and no funds) to do so.

The Tomahawk Project Office does not have a formalized V&V process for these (or any other models) which are used in conjunction with the TMPS or TMPCU. The Applied Physics Lab at Johns Hopkins University (JHU/APL) has “validated” other models, but the survivability models have not been validated or formally accredited. Ms. Russell’s group runs the models and compares the results with test data which have been collected. If anomalies in the models are detected, they are reported to SURVIAC. Sometimes, McDonnell Douglas is requested to analyze the anomalies and suggest model changes to SURVIAC. (A typical anomaly might be that the P_k obtained from test data differs from the model predicted value.) Mr. Nick Talarico, phone (314) 234-8870, is the point of contact at McDonnell Douglas for information about this model analysis.

Ms. Russell believes that the models should receive some sort of a "stamp of approval" from some external source, preferably from DOD. In particular, some sort of “domain accreditation” of M&S for a range of applications would be useful. Currently the PEO(CU) implicitly accredits a model by accepting the model results. The Tomahawk office does do an informal "face validation" on the input data which are used in the models.

If the project office is required to do V&V on these models, Ms. Russell feels that code verification and comparisons between model and test data are the two most important steps. In comparisons with test data, the usual guide for acceptability of model results is that they fall within ±10% of the test data. With regard to the utility of SMART products, she found them all to be of value but indicated that no one was demanding that such documentation be produced to support M&S usage.

Configuration control would also be a potential problem since the user community makes changes to various models. Ms. Russell commented that users put changes and fixes into the current C/M system without regard for (and supporting analysis of) how these changes may affect the overall model.

Ms. Russell indicated that she could run the models she is working with and provide assessments using the SMART process and the Tomahawk data if she were provided the necessary funding. The report from such an effort would be that the model(s) were or were not acceptable for use in certain new technology applications.

ARS INTERVIEW REPORT

INTERVIEWEES: Clayton J. Thomas (Chief Scientist) DATE: 2 April 1993
David E. Anderson (Scientific and Technical Advisor)
LTCOL Henry Pugh (Chief Analyst)

ORGANIZATION: Air Force Studies and Analysis Agency (AFSAA)

ORGANIZATIONAL RESPONSIBILITY: AFSAA conducts studies and performs analyses on major Air Force systems and/or operations for the Secretary of the Air Force and the headquarters offices.

INTERVIEW SUMMARY: AFSAA currently does not have a written policy which addresses VV&A for models used for their studies. AFSAA had a senior review panel (SRP) which conducted three reviews of a study project. During the first review, the justification for selection of a particular model was reviewed. That process was supplanted with an Analysis Review Panel, which is also defunct. Their current de facto policy is to use competent analysts and rely on them to scrub the models they use, to ensure that they are appropriate for the study or analysis and adequately reflect reality for the application at hand. AFSAA recently completed a detailed comparison of the STRAPEM and ROPES models that determined their limits of applicability to AFSAA problems, but it was not stated whether any formal process was used to complete the study.

Mr. Thomas believes that AFSAA analysts have the expertise to know how the models can be best used. He also recognizes that time constraints may dictate that some model which is not totally suited to a particular problem be used as is.

AFSAA is not the prime activity on any Air Force weapon system Cost and Operational Effectiveness Analysis (COEA). Some of their analyses are used in support of COEAs however. At times the use of a particular model is directed from above, and the analysts must make the necessary changes to fit the model to the study scenario. An example of this situation was the use of TAC BRAWLER for the F-22 COEA. In this case, TAC BRAWLER was declared to be the “accredited” model, and information supporting this accreditation was to be developed during the COEA.

Mr. Thomas believes that the Air Force should draft a centralized VV&A policy, and that it should be as permissive as the traffic can bear under the current DOD guidelines. He said he is working on such a policy now for GEN McInerny’s signature, but he did not give the time frame for completion.

M&S are constantly undergoing change. Mr. Thomas believes that the focus of VV&A should be on the changes for models which have been in use for several years, such as ESAMS. He stated that PA&E (Program Analysis and Evaluation, an OSD office) doesn't have much impact on model selection or accreditation for AFSAA uses.

Mr. Thomas perceives the SMART process as an scientific/engineering approach to VV&A which can provide information to support accreditation of the SMART models for

a class of applications. The analyst's job is to build on this work and do only the necessary additional work to ensure that the model is adequate for the particular application.

Mr. Anderson alerted us to the recent DOD IG report (93-060) entitled "Duplication/Proliferation of Weapon's Systems Modeling and Simulation within DOD." A copy of the report was requested from the Pentagon publications office.

A follow-on meeting was suggested to interview Dr. Al Murashige, MAJ William Behymer, and LTCOL. Henry Pugh to collect more detailed, working level information. (LTCOL Pugh was called away from this meeting shortly after it started.)

ARS INTERVIEW REPORT

INTERVIEWEE: Dr. Marion Williams (Chief Scientist) DATE: 5 February 1993

ORGANIZATION: Air Force Operational Test and Evaluation Center (AFOTEC)

ORGANIZATIONAL RESPONSIBILITY: Provides overall technical direction for the conduct of operational tests of Air Force aeronautical systems.

INTERVIEW SUMMARY: This interview was conducted after that of LTCOL Koozin. The questions were directed at specific issues or areas on which Dr. Williams could provide unique insights.

In response to a question about the criteria used to evaluate the adequacy of a M&S accreditation plan, Dr. Williams indicated that he would look for an accurate picture of the model. This "picture" should show the pieces of the model and state which pieces would be compared with what test data. The accreditation plan should also show the envelope within which the above comparisons are valid, what pieces of the model would not be validated, and what impact or risks would accrue from not validating the indicated pieces.

In AFOTEC, model analytical results are used in test planning, and to understand the impact of conditions that cannot be tested on conclusions drawn from Operational Test and Evaluation (OT&E). Due to Title 10 limitations on the use of M&S in OT&E, simulations cannot be used in lieu of operational testing to draw conclusions on system operational effectiveness and suitability. Typically, a test is run, the test results are compared with model predictions to calibrate the model, the results of a test under different conditions are predicted, and then tests at the new test point are conducted. If the model results compare favorably with the test results at this second point, the model is considered validated for the purpose at hand.

In developing the accreditation process, Dr. Williams was a key individual who insisted that the user is responsible for accreditation. He is rethinking that position. He believes that there may be some utility and benefit in having a model undergo some form of "general accreditation" similar to that described in Army Regulation 5-11. This general accreditation would serve as a starting point for a user's application-specific accreditation. In some cases the general accreditation would be sufficient to accredit a model for a particular application.

Dr. Williams, along with a team of other service representatives, will be doing an independent review of the SEAS (sp.) model accreditation.

The following personnel were stated to be important players in M&S accreditation:

GEN McInerny	Ass't Vice Chief of Staff	Special Ass't for M&S
MGEN Leaf (Ret.)	Heads AF T&E	
LTCOL Bruce Smith	AFSAA	Air Force DMSO representative
Greg Gurnsey	OPTEC	Good knowledge of accreditation

ARS INTERVIEW REPORT

INTERVIEWEE: LTCOL Walter Koozin DATE: 3 February 1993

ORGANIZATION: Air Force Operational Test and Evaluation Center, Systems Analysis Division (AFOTEC/SA)

ORGANIZATIONAL RESPONSIBILITY: Provides analytical support to AFOTEC in evaluating weapons' effectiveness during operational test and evaluation. Also provides modeling support to assist in test planning.

INTERVIEW SUMMARY: AFOTEC is developing internal policy guidelines which govern accreditation of M&S used in support of OT&E. This policy document has undergone several revisions. The current draft titled "The AFOTEC Accreditation Handbook" dated July 1992 (a copy was provided) is similar in policy to the previous drafts. The difference is in the amount of detailed guidance which is contained in the document. Although the current document doesn't address any independent review of the accreditation support material, Koozin reported that Dr. Marion Williams was interested in having an Independent Review Group participate in the accreditation process.

Current AFOTEC policy is that if analytical results obtained through the use of M&S is to be used in any formal report to support an acquisition decision, or in any operational assessment of a system, then the M&S used must be formally accredited. If a M&S is to be used merely to support test planning, it does not need to be accredited. However, the SA division attempts to use M&S with which they are familiar and in which they have some confidence that the results are credible.

In discussing policies of other AF commands, LTCOL Koozin did not know what their accreditation requirements were. However, his personal opinion is that any M&S which is used in tactics development, or other similar applications where major impacts can be felt, should be formally accredited.

The SA division has not developed any accreditation plans nor accredited any models under the new policy guidelines now being finalized. Previously developed accreditation plans were not very good and should not be used as a model of a "good" plan.

Within AFOTEC, the ST (Special Test) division does configuration management (CM) for their changes. They feed information on these changes back to the user community. Their documentation for these changes may not be considered adequate. LTCOL Koozin feels that CM is a critical part of the accreditation decision, especially if historical data are to be used for any part of the accreditation decision.

In making the selection of a model for a particular analytical application, the candidate model V&V histories should be reviewed. The information on past confidence enhancements should be part of the considerations affecting model selection. It was LTCOL Koozin's opinion that SMART should develop its own assessment of the confidence that can be placed in each model. SMART should develop its own level of confidence in the model set included in the project, and make specific statements about

the confidence that can be placed in the model results. Any parts of the models which have not been assessed should be identified. Those areas which have been shown through sensitivity analyses to have the greatest impact on the output should also be highlighted. Such a general assessment from SMART would be useful as a basis from which application specific assessment may be performed by the user.

Currently the Air Staff (XORN) has “pseudo-authority” for M&S. They are the de facto focal point of contact for M&S issues. Air Force attention on M&S accreditation is driven by the draft DOD directive on M&S. A possible point of contact for additional accreditation discussions is LTCOL Bruce Smith at the Air Force Studies and Analysis Agency (AFSAA). A second potential contact is Rich Woodard, AFDTC/XRI, at (904) 882-3890.

LTCOL Koozin's personal opinion is that models which have been developed IAW MIL-STD 2167A do not require additional verification as long as no changes are made to the model.

ARS INTERVIEW REPORT

INTERVIEWEE: Donald Giadrosich DATE: 1 October 1993

ORGANIZATION: Operations Analysis Division, Air Warfare Center, Eglin AFB

ORGANIZATIONAL RESPONSIBILITY: The Operations Analysis Division participates in developing models used in trainers and for training systems. They also help the Air Combat Command in performing studies related to requirements definition and operational demonstrations. They participate in follow-on OT&E, tactics development, and system usage planning.

INTERVIEW SUMMARY: In the opinion of Mr. Giadrosich the most critical part of any study or analysis is the proper selection of the measures of performance or measures of effectiveness which will be used to develop the study conclusions. Using inappropriate MOPs or MOEs can lead to erroneous results, even if the model or simulation used in the study is an accurate representation of the system(s) under study. The example Mr. Giadrosich used was a study of two alternate Electronic Counter Measures (ECM) systems. A measure of effectiveness for the systems might be the survivability of the protected aircraft. If the model produced results showing that the aircraft survivability was equally good for each system, the conclusion would be that either system could be used. However, if the aircraft was an attack aircraft and the measure of effectiveness was the ability of the aircraft to destroy a target with the minimum chance of aircraft damage, one system might prove more effective than another. This change in study conclusions would result if one system required tactics which impeded or constrained the aircraft's ability to locate and attack a target whereas the other system imposed no such constraints.

Another issue which Mr. Giadrosich raised was the tendency of analysts and persons responsible for directing a study to use available models for that study even though the selected model might not be totally appropriate. The typical reasons that this tendency exists are:

- no other appropriate models exist and time does not permit new model development;
- unfamiliarity with other models
- the selected model is recognized and accepted by decision makers
- direction of senior decision makers.

ARS INTERVIEW REPORT

INTERVIEWEES: Richard Woodard
LTCOL Randy Enright
Brad Atherton
Dr. Choltia Posey
Robert Jones

DATE: 30 September 1993

ORGANIZATION: Air Force Development Test Center (AFDTC), Eglin AFB

ORGANIZATIONAL RESPONSIBILITY: The AFDTC is responsible for performing development tests on new and modified aircraft and installed systems. They use models, particularly missile flyout models, as part of their hardware-in-the-loop simulations.

INTERVIEW SUMMARY: Mr. Jones and Dr. Posey are primarily involved in developing the models used in the various simulations. Mr. Jones was the principal spokesperson for the group.

In order to provide an understanding of how AFDTC fits in with the other air force organizations, Mr. Jones provided a partial organizational chart showing the various commands and their relationships. That partial chart is attached.

AFDTC does not have any formal accreditation requirements for the models they develop and use. There is no effort underway to develop such requirements. They do follow the SIMVAL process for model V&V thus ensuring that the models conform to the Defense Intelligence Agency (DIA) baselines.

The models they develop are typically detailed six degree of freedom aerodynamic models of threat missiles which are integrated with real hardware to provide an overall simulation of a threat system. Because of this integration with real hardware, their models should have high fidelity and capable of real time or near real time operation. The fidelity requirements vary. Typically their design goal is that the model compare with real system performance parameters within ±3%. This figure is a rule of thumb based on past experience and judgment. It is not derived from any analysis of a specific problem. (Comparisons with DIA threat baseline data are made at the equivalent of the SMART functional element level.)

Their model development is done following the spirit of MIL STD 2167A. However, the formal documentation is generally not prepared since the development is done by government personnel for their own use. In some cases a model may be sent to FASTC who will perform the comparison with the DIA baseline data. In these cases FASTC will prepare a formal Acquisition Validation Report. This report is considered sufficient validation for the model.

ARS INTERVIEW REPORT

INTERVIEWEE: Gerald B. Bennett DATE: 4 February 1993

ORGANIZATION: Aeronautical Systems Command, Studies & Analysis Division (ASC/XR)

ORGANIZATIONAL RESPONSIBILITY: Provides analytical support to ASC to assess weapons' effectiveness, estimate costs, and perform preliminary design. Use a variety of models including vulnerability, survivability, cost, and campaign models.

INTERVIEW SUMMARY: When performing an analysis, the first step the analyst takes is the selection of a model. This selection is based on what type of information is needed, how this information is to be used, what money is available for the assessment, and how much time is available. A particular model is selected by the technical leader who is responsible for the assessment and who must justify the selection to the program manager who requested the assessment.

XR hasn't performed a formal accreditation in the past. They do perform verification, validation and sensitivity analyses. Within XR, each group is responsible for a selected set of models. They maintain familiarity with these models, do the necessary V&V to maintain confidence in them, and perform analyses using them. The amount of V&V done is based on a subjective judgment of the technical analysts who are familiar with the models. They try to perform V&V as necessary to establish a consensus within the technical group that the model results in a particular application will be reliable.

The analysts do perform a lot of what is termed “verification.” They select simple problems for which solutions can be calculated manually. These results are compared with the predictions from selected model components.

Even if a model were developed in accordance with MIL-STD 2167A and other required standards, ASC would still want to do their own verification of a model since they almost always make changes to a model prior to analytical use.

When making any changes to a model, these changes are documented with the liberal use of comments in the code. They insert comments at the beginning of each subroutine that list the date of the most recent change and describe the function and limits of that subroutine. Updated models with the comments inserted are fed back to SURVIAC.

Another problem which is equally as important to ASC as model validation and accreditation, is the accreditation of the data bases used to provide input data to the models. The information contained in these data bases is generally either intelligence information or data related to friendly systems. These must also be accredited. A person to interview concerning data base maintenance is Kevin McCardle at Eglin Code ENY. He maintains an Attrition Data Base and might be helpful in defining the SMART data base requirements. Other contacts are Frank Campanile, Larry Boyd, and Larry Beasely. They can be contacted through Mr. Weisenbach at the same location.

Another source of information on accreditation might be the Avionics Laboratory at Wright Laboratories in Dayton, Ohio. They do ECM modeling. The J-MASS program should be contacted to determine what their plans for VV&A might be.

Mr. Bennett did not know of any instance when the results of any of their analyses were rejected because the credibility of the model was in question.

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. Michael Weisenbach DATE: 26 May 1993
Dr. Jerry Arnett
Mr. Jordan Wescott

ORGANIZATION: Aeronautical Systems Center, Studies & Analysis Division (ASC/XR)

ORGANIZATIONAL RESPONSIBILITY: Provides analytical support to ASC to assess weapons' effectiveness, estimate costs, and perform preliminary design. Use a variety of models including vulnerability, survivability, cost, and campaign models.

INTERVIEW SUMMARY: The Studies and Analysis Division may perform studies to support either ASC or the System Project Officers (SPOs) directly. They may also perform studies for the Air Staff or the Air Combat Command (ACC) since the ACC is responsible for a project through Milestone 1.

The studies assigned to XR are of various sizes and levels of complexity. Depending on size, one person to a team may be assigned to perform the study. For short term studies, which tend to be the simpler studies, they normally use the "informal process". For longer term studies they usually follow the "semi-formal process" Whichever process they follow, they have an agreement with the study sponsor as to what level of involvement the sponsor will have. The choice of process depends a great deal on the time available for the study and the manpower available to perform the work.

For most studies they use legacy models, the primary one being ESAMS. They feel that legacy models are valid and do not require additional V&V unless they make changes to the model. If changes are made, they do testing of the code as the changes are made. If these changes are not to be exported to other users, no formal V&V is done on the changes. They don't document any of the testing they do but they do document the changes themselves with lab notes. Although there is no official requirement to distribute information on their in house changes, MAJ Behymer is interested and is sent copies of any ESAMS changes.

They have a working relationship with MSIC who have done a comparison of select Low Observable (LO) cases between IMARS and ESAMS. The results of these comparisons have not been documented and shared. However, the point of contact for further information is Klaus Bletzinger 255-701 6.

In this case as well as for mode comparisons in general, the results of such comparisons may not be available since the comparisons also involve system comparisons. Such comparisons may not be politically tenable.

They have developed a matrix of SAM simulations. This matrix includes a list of phenomenology which might be useful in structuring the data base. They will send us a copy of this matrix.

The interviewees felt strongly that a validated model did not ensure a good analysis. Good data is needed and the analyst must understand how the model works, how data is treated in the model, and how the model outputs are generated. In this way the analyst will know if the results are valid for the particular problem which is being analyzed.

They suggested that some additional information might be gained by interviewing their counterparts in the Electronics Systems Center at Hanscomb AFB. They suggested COL O'Prey ESC/XRP as a point of contact. They also suggested that LTCOL. Hathaway, USAF/XOM also be contacted.

ARS INTERVIEW REPORT

INTERVIEWEE: Christopher Pfledderer
Douglas McCown

DATE: 1 October 1993

ORGANIZATION: Aeronautical Systems Command, Air-to-Air Systems Analysis (ASC/XREWA)

ORGANIZATIONAL RESPONSIBILITY: Provides analytical support to ASC in performing effectiveness analyses, end game simulations, and air target vulnerability modeling. They also operate a MIL-AASPEM modeling facility.

INTERVIEW SUMMARY: ASC/XREWA does not have any formal, published accreditation requirements or guidelines. The feeling of the personnel within their section and their own feeling is that any model in SURVIAC has some degree of acceptability. The selection and use of a model for a particular application depends somewhat on its usage history. Previous usage tends to build confidence in the model's fidelity and accuracy. After listening to the accreditation requirements briefing, they agreed with Messrs. Bennett and Weisenbach that ASC will use either process 1 or process 2 in performing an analytical study.

Time constraints on a study or analysis is often a factor forcing the selection and use of an available model for a given study, even if the available model does not fit all of the study requirements. The requirement for some answer outweighs the need for accurate representation of all the conditions surrounding the problem. This time constraint is often dictated or passed on by the person who normally would accredit a model (e.g. the program manager).

In their opinion, the definition of acceptance criteria for the use of a model in a particular application often cannot be done completely prior to initiating the study. It often may be necessary to actually begin the study and obtain initial results. In evaluating these results some additional criteria might be uncovered.

They also mentioned that some models might not be totally acceptable (i.e. they might not meet all of the acceptance criteria). However the model might still be used since it is the best or only one available.

In discussing the notional process which is described in the briefing, they questioned whether DOD would accept accreditation decisions which were made within the services or if DOD would require some separate justification for the selection and use of a particular model. Their experience is that DOD decision makers in many cases will not accept the justification provided for some study results which include model usage. DOD will often require additional sensitivity analyses to prove model outputs and study conclusions are valid.

ASC often used historical data on model usage as a basis for a "de facto" accreditation. One of their thrusts is to document any models which they use that don't have users and analysts manuals.

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. Michael Murray DATE: 26 May 1993

ORGANIZATION: Wright Laboratory - Electronics laboratory

ORGANIZATIONAL RESPONSIBILITY: The division develops models to support the laboratory or project managers.

INTERVIEW SUMMARY: Mr. Murray has directed the development of a model called MOSAIC which stands for "Modeling System for ASTE Investigation of Countermeasures". ASTE stands for Advanced Strategic and Tactical Expendables and is a project which has completed DEMVAL and is in engineering development. He has contracted for the application of the J-MASS VV&A process to the VV&A of MOSAIC. The task was started after the model coding was well underway. The delay in starting the VV&A was due to a lack of funds.

The VV&A effort was impacted by the lack of timely test data and the time and effort required to train the VV&A contractor personnel. Although they were involved in the test planning phase and agreements to share data were worked out, when test program difficulties occurred, the VV&A test objectives were the first to be impacted. He is still pursuing the V&V effort. We agreed to review the draft VV&A document to determine what elements are similar to other accreditation requirements. We will also provide comments on the documents.

MOSAIC is becoming more popular. The A/FX program, which is now a joint program, has requested the model for their analysis. The ESC Combat Systems Research Lab will have the responsibility for CM on the model. If the SMART CM study personnel want to contact some of these CM people, Mr. Murray can provide a point of contact.

The data which is being gathered to validate MOSAIC can be made available to SMART. Since it is IR sensor data for validation of the IR portions of MOSAIC, it should be useful in validating the IR portions of ESAMS.

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. James Vernon
Dr. Al Murashige (AFSAA)

DATE: 8 July 1993

ORGANIZATION: Headquarters USAF/XOM

ORGANIZATIONAL RESPONSIBILITY: This staff organization has been established to be the focal point for modeling simulation and analysis.

INTERVIEW SUMMARY: Mr. Vernon indicated that the XOM office was recently established and they were just starting to deal with the issue of developing an Air Force VV&A policy. (He is responsible for M&S VV&A within the office.) He feels that drafting a policy would be very simple in view of the huge amount of VV&A policy, guidance, and philosophy documents which already exist. He indicated that implementing the policy would be the difficult aspect.

His approach would be to promulgate a trial policy and attempt to implement it for a select set of models. After listening to a presentation on the interim results of this accreditation study, Mr. Vernon indicated that a set of "decision rules" are the key to a successful accreditation. His meaning for the term "decision rules" is a set of guidelines which should be followed to allow a decision maker to determine if a M/S was suitable for a particular application. These decision rules are essentially similar to a checklist of things to look for in a M/S. It also embodies the concept of the acceptance criteria which have been identified by several model users as being a critical factor in model VV&A.

Mr. Vernon provided a brief description of the XOM mission and functions as well as an office organization.

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. Kevin Crosthwaite
Mr. Dennis Detamore

DATE: 27 May 1993

ORGANIZATION: Booz-Allen Hamilton (SURVIAC)

ORGANIZATIONAL RESPONSIBILITY: SURVIAC has the responsibility for maintaining a library of approved survivability models. Booz-Allen Hamilton (BAH) operates the library under the direction of a SURVIAC steering committee.

INTERVIEW SUMMARY: When a model is recommended for general distribution by a cognizant authority, the SURVIAC steering committee decides if it should be included in the library. When it is approved by the steering committee, BAH takes a copy of the model and runs it on their computer. They run several test cases for which they have results from running previous versions of that model or similar models. (These test cases are provided by the model developer.) If the results are consistent with previous runs the model is made available for distribution to users.

They pointed out that the copy of the FEAR which they received and reviewed did not contain the type of information which they expected and which users need to ensure that the model is operating correctly. Specific comments on the draft FEAR were provided.

ARS INTERVIEW REPORT

INTERVIEWEE: Donald Martinovich
Dan Sammons (SVERDRUP)

DATE: 27 May 1993

ORGANIZATION: SIMVAL Program and J-MASS

INTERVIEW SUMMARY: The SIMVAL program validates simulators against DIA baselines. They obtain their data from the CROSSBOW Executive Committee. If sufficient data is not available, they develop the data and coordinate with the lead service Science and Technology (S&T) to gain approval or concurrence on the data.

Their comparisons between the simulator and the DIA baseline is done at four different levels. They compare 1) descriptions of the systems, 2) functions, 3) parameters derived from specific model runs, and 4) performance factors such as frequency response or step response. Recently they are leaning toward performance comparisons to validate a simulator. If the comparison results are not satisfactory, they proceed to other levels of comparison to find the problem in the simulator. Currently, they are doing a comparison between ESAMS and IMARS which is the DIA approved baseline.

If there is no DIA approved baseline and they cannot develop the necessary data, they have six degree of freedom (DOF) models which they use for generating data to compare with simulator outputs. This data is not DIA approved and they only use these 6-DOF models if no other data is available.

Their V&V process includes efforts by both the developer and an independent group. They prepare a test matrix which considers both observed performance of the model and model requirements. The testing which is done is similar to module testing which we do as part of verification.

They mentioned that they use the standard validation criteria which is found in the appendices of the Threat Simulation Program Plan which is available from CROSSBOW. A quick review of these appendices shows that these "criteria" are lists of test parameters and their relationships to each other. The "criteria" do not include fidelity requirements for any of the parameters. The information in these appendices would provide little insight into what the fidelity requirements might be for different classes of applications.

The authority and guidelines for performing their V&V are spelled out in DODINST 5000.2, AFR 8025 and DOD 5000.3-M-6. This latter document which is titled "Threat Simulation Program Policy and Procedures" is now canceled but they use it to guide their efforts. The Navy persons who are involved in SIMVAL is Jim Fusner at China Lake. His number is 939-2878. Al Dunkerly of ARI who provides support to CROSSBOW is another person who might be a worthwhile point of contact. His number is (703) 243-8448.

ARS INTERVIEW REPORT

INTERVIEWEE: Mr. John Freeman DATE: 9 June 1993

ORGANIZATION: Defense Modeling and Simulation Office

ORGANIZATIONAL RESPONSIBILITY: Acts as a full time focal point for information concerning M&S activities. Responsible for promulgating USD(A) directed policy, initiatives, and guidance to promote cooperation among DOD components to maximize M&S efficiency and effectiveness.

INTERVIEW SUMMARY: A meeting was held with Mr. John Freeman in the DMSO. The purpose of the meeting was to determine what, if any, information concerning accreditation requirements could be obtained from that office. Mr. Freeman opined that the services have been responding to DOD and are engaged in developing policies and procedures addressing M&S accreditation. Now the services are, in effect, asking DOD for an opinion as to whether the policies and procedures which have been developed meet DOD expectations. In response to this question, DOD is now wrestling with the issue and is preparing a directive or instruction which expresses the DOD position and viewpoint. Currently, the DMSO does not have any expressed policy or guidelines on either the process to be used or the information required to support accreditation.

Mr. Freeman explained that the DOD organization is undergoing change. A new organizational structure has been drafted and is being reviewed. Since the DMSO is not shown on that new diagram, he is unsure as to the future of the office. However, CAPT McClure, the present OPNAV 812, has been named as the new director of DMSO. Therefore, they expect to continue in their present role, albeit in a new organizational structure. (As a side note, CAPT Tom Travis will be replacing CAPT McClure in N-812.)

Mr. Freeman also provided some background information on the DMSO and how it came into being. He pointed out that the director has discretionary control over about 20% of the DMSO funds. There is a formal process for submission of proposals to obtain some of this discretionary funding.